JOURNAL

OF THE

SOCIETY OF ARTS.

VOLUME XXXV.

FROM NOVEMBER 19, 1886, TO NOVEMBER 11, 1887.

LONDON:
PUBLISHED FOR THE SOCIETY BY GEORGE BELL AND SONS,
4, 5, & 6, YORK STREET, COVENT GARDEN.

1887.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1774.] *FRIDAY, NOVEMBER* 19, 1886. [*Vol.* XXXV.

ONE-HUNDRED-AND-THIRTY-THIRD SESSION, 1886-87.

SESSIONAL ARRANGEMENTS.

The First Meeting of the One Hundred and Thirty-third Session of the Society was held on Wednesday, the 17th November, when the Opening Address was delivered by Captain Douglas Galton, C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, when papers will be read by Mr. Anderson, General Webber, and Mr. J. B. Marsh.

ORDINARY MEETINGS.

Wednesday evenings at Eight o'clock. The following dates have been fixed:—

November 24.—William Anderson, M.Inst.C.E., "Purification of Water by Agitation with Iron and by Sand Filtration." Captain Douglas Galton, C.B., F.R.S., will preside.

December 1.—Adjourned discussion on the paper by Dr. C. Meymott Tidy, on "Sewage Disposal." (Read April 14, 1886.)

" 8.—Major-General C. E. Webber, R.E., C.B., "Glow Lamps, their use and manufacture."

" 15.—J. B. Marsh, "Cameo Carving as an Occupation."

For Meetings after Christmas :—

Edward H. Liveing, "Miners' Safety Lamps."
Prof. Silvanus P. Thompson, D.Sc., "Development of the Mercurial Air-pump.
J. Traill Taylor, "Photographic Lenses."
Percy Fitzgerald, "Scenery and Stage Machinery."
John W. Urquhart, "Recent Advances in Sewing Machinery."
C. F. Cross, "Textile Fibres in the Colonial and Indian Exhibition."
Rev. Canon Bagot, "Irish Industries."
A Gordon Salomon, "Adulteration of Beer."
William Henry Preece, F.R.S., "Progress in Telegraphy."
William P. Marshall, "Railway Brakes."
A. Reckenzaun, "Electric Locomotion."

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday evenings at Eight o'clock :—
January 25; February 15; March 1, 29; April 19; May 17.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock :—
January 21; February 11; March 4, 25; April 29; May 27.

CANTOR LECTURES.

The First Course will be on "Principles and Practice of Ornamental Design," By Lewis Foreman Day.
November 29; December 6, 13, 20.

The Second Course will be on "Diseases of Plants, with special reference to Agriculture and Forestry," by T. L. W. Thudichum, M.D. Three Lectures.
January 24, 31; February 7.

The Third Course will be on "Building Materials." By W. Y. Dent, F.C.S., F.I.C. Four Lectures.
February 14, 21, 28; March 7.

The Fourth Course will be on "Machines for Testing Materials, especially Iron and Steel." By Prof. W. C. Unwin. Three Lectures.
March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Structure of Textile Fibres." By Dr Frederick H. Bowman, F.L.S., F.G.S. Five Lectures.
April 25; May 2, 9, 16, 23.

JUVENILE LECTURES.

Two Juvenile Lectures on "Soap Bubbles," by Prof. A. W. Reinold, F.R.S., will be given on Wednesday evenings, January 5 and 12, 1887, at Seven o'clock.

PROCEEDINGS OF THE SOCIETY.

Charter.—The Society of Arts was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom;

and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

The Session.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

Ordinary Meetings.—At the Wednesday Evening Meetings during the Session papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

Indian Section.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

Foreign and Colonial Section.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

Cantor Lectures.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of from Three to Six Lectures.

Additional Lectures.—Special Courses of Lectures are occasionally given.

Juvenile Lectures.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

Admission to Meetings.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

Journal of the Society of Arts.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

Examinations.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Political and Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

Conversazioni are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1886-87. It is issued subject to any necessary alterations:—

NOVEMBER, 1886.			*DECEMBER*, 1886.			*JANUARY*, 1887.			*FEBRUARY*, 1887.		
1	M		1	W	Ordinary Meeting	1	S		1	Tu	
2	Tu		2	Th		2	S		2	W	Ordinary Meeting
3	W		3	F		3	M		3	Th	
4	Th		4	S		4	Tu		4	F	
5	F		5	S		5	W	Juvenile Lecture 1	5	S	
6	S		6	M	Cantor Lecture I. 2	6	Th		6	S	
7	S		7	Tu		7	F		7	M	Cantor Lecture II. 3
8	M		8	W	Ordinary Meeting	8	S		8	Tu	
9	Tu		9	Th		9	S		9	W	Ordinary Meeting
10	W		10	F		10	M		10	Th	
11	Th		11	S		11	Tu		11	F	Indian Section
12	F		12	S		12	W	Juvenile Lecture 2	12	S	
13	S		13	M	Cantor Lecture I. 3	13	Th		13	S	
14	S		14	Tu		14	F		14	M	Cantor Lecture III. 1
15	M		15	W	Ordinary Meeting	15	S		15	Tu	For. & Col. Section
16	Tu		16	Th		16	S		16	W	Ordinary Meeting
17	W	Ordinary Meeting (Opening Meeting of the Session)	17	F		17	M		17	Th	
18	Th		18	S		18	Tu		18	F	
19	F		19	S		19	W	Ordinary Meeting	19	S	
20	S		20	M	Cantor Lecture I. 4	20	Th		20	S	
21	S		21	Tu		21	F	Indian Section	21	M	Cantor Lecture III. 2
22	M		22	W		22	S		22	Tu	
23	Tu		23	Th		23	S		23	W	Ordinary Meeting
24	W	Ordinary Meeting	24	F		24	M	Cantor Lecture II. 1	24	Th	
25	Th		25	S	Christmas Day	25	Tu	For. & Col. Section	25	F	
26	F		26	S		26	W	Ordinary Meeting	26	S	
27	S		27	M	Bank Holiday	27	Th		27	S	
28	S		28	Tu		28	F		28	M	Cantor Lecture III. 3
29	M	Cantor Lecture I. 1	29	W		29	S				
30	Tu		30	Th		30	S				
			31	F		31	M	Cantor Lecture II. 2			

MARCH, 1887.			*APRIL*, 1887.			*MAY*, 1887.			*JUNE*, 1887.		
1	Tu	For. & Col. Section	1	F		1	S		1	W	
2	W	Ordinary Meeting	2	S		2	M	Cantor Lecture V. 2	2	Th	
3	Th		3	S		3	Tu		3	F	
4	F	Indian Section	4	M	Cantor Lecture IV. 3	4	W	Ordinary Meeting	4	S	
5	S		5	Tu		5	Th		5	S	
6	S		6	W		6	F		6	M	
7	M	Cantor Lecture III. 4	7	Th		7	S		7	Tu	
8	Tu		8	F	Good Friday	8	S		8	W	
9	W	Ordinary Meeting	9	S		9	M	Cantor Lecture V. 3	9	Th	
10	Th		10	S	Easter Sunday	10	Tu		10	F	
11	F		11	M	Bank Holiday	11	W	Ordinary Meeting	11	S	
12	S		12	Tu		12	Th		12	S	
13	S		13	W		13	F		13	M	
14	M		14	Th		14	S		14	Tu	
15	Tu		15	F		15	S		15	W	
16	W	Ordinary Meeting	16	S		16	M	Cantor Lecture V. 4	16	Th	
17	Th		17	S		17	Tu	For. & Col. Section	17	F	
18	F		18	M		18	W	Ordinary Meeting	18	S	
19	S		19	Tu	For. & Col. Section	19	Th		19	S	
20	S		20	W	Ordinary Meeting	20	F		20	M	
21	M	Cantor Lecture IV. 1	21	Th		21	S		21	Tu	
22	Tu		22	F		22	S		22	W	"Annual Conversazione" (probable date)
23	W	Ordinary Meeting	23	S		23	M	Cantor Lecture V. 5	23	Th	
24	Th		24	S		24	Tu		24	F	
25	F	Indian Section	25	M	Cantor Lecture V. 1	25	W	Ordinary Meeting	25	S	
26	S		26	Tu		26	Th		26	S	
27	S		27	W	Ordinary Meeting	27	F	Indian Section	27	M	
28	M	Cantor Lecture IV. 2	28	Th		28	S		28	Tu	
29	Tu	For. & Col. Section	29	F	Indian Section	29	S	Whit Sunday	29	W	Annual General Meeting
30	W	Ordinary Meeting.	30	S		30	M	Bank Holiday	30	Th	
31	Th					31	Tu				

The chair will be taken at eight o'clock at each of the above meetings, except the Annual General Meeting and the Juvenile Lectures.

The Annual General Meeting will be held at four o'clock.

The Juvenile Lectures will be given at seven o'clock.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 17th, 1886; Captain DOUGLAS GALTON, C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Abel, Charles Denton, 11, East Coombe-villas, Blackheath, S.E.
Baxter, Charles Edward, 24, Ryder-street, S.W.
Beall, George, 21, Fountayne-road, Stoke Newington, N.
Bennett, Lieutenant-Colonel, Yorkshire Regiment, Assouan, Upper Egypt.
Bird, William Macdonald, 5, Gloucester-crescent, Hyde-park, W.
Bonn, John Edwin James, Brading, Isle of Wight.
Bradshaw, William, M.D., 122, Holland-road, W.
Bucknall, Edward, 78, Junction-road, Highgate, N.
Burr, Ebenezer Bantor, 85, Gracechurch street, E.C.
Cargill, William Walter, Lancaster-lodge, Campden-house-road, W.
Charubin, Gustavus A., 8, Finch-lane, E.C.
Clyne, Arthur, 6, Golden-square, Aberdeen.
Cole, Major-General Robert, Woolmer-lodge, Burgh-heath, Banstead.
Cousins, Edward, Palace-chambers, Westminster, S.W.
Cowie, George, 93, Philbeach-gardens, Earl's-court, S.W.
Cruttenden, Henry Edward, Brittany-house, London-road, St. Leonards-on-Sea.
Dangar, Frederick Holkham, Lyndhurst, Castle-hill, Ealing, W.
De Colyar, Henry Anselm, 24, Palace-gardens-terrace, W.
De Lissa, Samuel, 64, Onslow-gardens, S.W.
D'Monte, Dominic A., M.D., Bandora, Bombay.
Densham, George W., 45, Cochrane-street, St. John's-wood, N.W.
Douglas, Thomas, Greenwood, Frant, Tunbridge Wells.
Ebbs, Alfred, 2, Southampton-street, Bloomsbury, W.C.
Edwards, Walter Cleeve, Engineer in Chief's-office, Wellington-Manawatu Railway Company, Wellington, New Zealand.
Flint, John Henry, Oaklands, Grove-park, Lee, S E.
Fox, William, Leeds Forge Company, Limited, Leeds.
Game, James Aylward, Westwood-lodge, Sydenham, S.E., and Yeeda-grange, Trent, New Barnet, Herts.
Gauntlett, William Henry, Middlesbrough-on-Tees.
Gibbins, Richard Cadbury, Berkley-street, Birmingham.
Gilbert, John J., 72, Cambridge-street, The Crescent, Birmingham.
Goulty, Wallis Rivers, Albert-chambers, Albert-square, Manchester.
Grant, John Macdonald, Queensland Government-office, 1, Westminster-chambers, S.W.
Greswell, William Henry Parr, M.A., Stowey-court, Bridgwater, Somerset.
Gulland, James Ker, 6A, Victoria-street, S.W.
Harrison, Charles, M.D., 30, Newland, Lincoln.
Harrold, Leonard Frederick, Wanstead-hall, Snaresbrook, Essex.
Haskins, John Ferguson, 114A, Queen Victoria-street, E.C.
Hawthorn, James Kenyon, Glenholme, Leigham-court-road, Streatham-hill, S.W., and 5, Lime-street-square, E.C.
Hoffnung, S., 3, Hyde-park-gate, S.W.
Ison, Edward, Mountfield, Ashby-de-la-Zouch.
Jackson, Arthur C., Hardwick, Vermont, United States, America.
Jennings, John Rogers, Minster Lea, Reigate, Surrey.
Keays, Arthur Maitland, 11, Burch-road, Rosherville.
Kinninmont, A. T., 26, Chilworth-street, W.
Kirkcaldie, Robert, Villa Rosa, Potter's Bar, Middlesex, and 27, Milton-street, E.C.
Knowles, Charles, St. Cuthbert's, Marlborough-road, Putney, S.W.
Lascelles, John, 13, Percy-road, Shepherd's-bush, W.
Lawe, Captain Patrick Molle, Junior Army and Navy Club, S.W., and Constitutional Club, S.W.
Lawrie, Alexander, Raggles-wood, Chislehurst, Kent.
Lay, Edward Warren, The Limes, North-end, Hampstead, N.W.
Lehmaier, George, 11, Queen Victoria-street, E.C.
Lovett, Henry Albert James, B.A., 1, Guildhall-chambers, Basinghall-street, E.C.
McIntyre, J.P., 3 and 4, New Basinghall-street, E.C.
Mackay, Robert Fenton, 3, Rose Angle, Dundee.
Manbré, Alexander, 21, Blackstock-street, Liverpool.
Marshall, Arthur, Third Avenue, Sherwood-rise, Nottingham.
Marshall, Sir James, C.M.G., Richmond-house, Roehampton, S.W.
Mash, John William, 48, Tollington-park, N.
Mason, Hugh Herbert, M.R.C.S., Abbey-lodge, Barking, Essex.
Mews, John, J.P., 103, Westbourne-terrace, W., and Hartwell-house, Hartfield, Tunbridge Wells Kent.
Moodie, George Pigot, Sussex-lodge, Kingston-hill, Surrey.
Mooney, Joseph J., Tib-street, Manchester.
Moore, Arthur Chisholm, 23, Essex-street, Strand, W.C., and The Lodge, Boreham, Chelmsford.

Mullens, John Ashley, Broom-hall, Teddington.
Nanson, Tom, 9, Park-crescent, Stockwell-park-road, S.W.
Niven, George, Erkingholme, Coolhurst-road, N.
Peake, George Herbert, B.A., LL.B., 1, St. James's-street, S.W.
Perry, William, Hanbury-villa, Stourbridge.
Phillips, Robert Edward, 70, Chancery-lane, W.C.
Poore, Graydon, 49, Queen Victoria-street, E.C.
Purvis, Gilbert, 5, Bow Church-yard, E.C.
Radford, John Charles, 113, High-street, Putney, S.W.
Rylands, Frederick, Westmead, Augustus-road, Edgbaston, Birmingham.
Saunders, George, The Mall, Chiswick.
Simmons, Nimrod, Victoria-street, Clifton, Bristol.
Smith, Sir Francis Villeneuve, 19, Harrington-gardens, South Kensington, S.W.
Stenning, Alexander Rose, 121, Cannon-street, E.C.
Tanner, Henry, 15, Whitehall-place, S.W.
Taylor, John, 29, Portman-square, W.
Webb, Henry Barlow, 7, Warrior-square-terrace, St. Leonards on-Sea.
Whiting, Matthew, Lavender-hill, Wandsworth, S.W.
Willes, W. A., The Manor House, King's Sutton, Banbury, and Arthur's Club, St. James's-street S.W.
Wood, Jacob, Lentridge-house, 186, Highbury New-park, N.
Wonnacott, Thomas, Devonshire-house, Farnham, Surrey.
Young, Jasper, Mayfield, Clapham-park, S.W.

AND AS HONORARY CORRESPONDING MEMBERS :—

Hayter, Henry B., C.M.G., Melbourne, Victoria.
Von Haast, Sir Julius, K.C.M.G., F.R.S., Christ-church, Canterbury, New Zealand.

The CHAIRMAN delivered the following

ADDRESS.

A RETROSPECT.

In opening the meetings of the One Hundred and Thirty-third Session, it appeared to me that, as we are entering upon the jubilee year of the Queen's reign, it might be interesting to take stock, as it were, of the progress which has been made by the nation in some one of the branches of usefulness to which the proceedings of this Society have contributed; and it occurred to me that the most fitting subject to select would be that of the progress which has been made in sanitation during her Majesty's reign.

The Queen's accession occurred during an epoch of important social changes.

A fall in prices and in wages had followed the termination of the great war. The substitution of machinery for hand labour had occasioned considerable alterations in the condition of the labourer; for whilst this substitution proved of immense benefit to the nation, it told heavily on those who were brought up in the old ways. It removed manufactures to new localities; it threw large numbers of workmen out of employment; and the conditions of labour had scarcely become adjusted to the new order of things, when the Queen ascended the throne.

Fevers were rife among the poor, food was dear, the poverty of the very poor was intense; one person out of every eleven was a pauper, and one person out of every 500 was committed for trial.

REGISTRATION OF BIRTHS, DEATHS, AND MARRIAGES.

The first decennial census of the population of England and Wales had been taken in 1801, in which year the population of England was 8,892,536. At the Queen's accession it had risen to 15,268,056, but it was only then that civil registration of births, marriages, and deaths, including the registration of the diseases which were the causes of death, first came into operation.

The Queen's accession to the throne took place on the 20th of June, 1837, and the registration came into operation on the following 1st of July, and thus the jubilee year of the Queen's reign is the jubilee year of registration of disease.

To the sanitarian the principal value of registration has been that it furnished a basis of accurately observed facts which has enabled the medical man to substitute numerical expressions for vague conjecture, and by affording the necessary data for ascertaining the prevalence and intensity of epidemics, has led to an examination of the existing causes of the diseases.

This knowledge was the first step towards their prevention.

Thus registration of the causes of death forms the basis upon which all scientific sanitary investigation necessarily rests; therefore the year of the Queen's accession forms the commencement of intelligent sanitary progress in this country.

Dr. Farr, in submitting the abstracts of the recorded deaths for the first half-year of regis-

tration, between the 30th of June and the 31st of December, 1837, draws attention to this, and, after showing that a considerable proportion of sickness and death may be expected to be suppressed by social progress, and the general adoption of hygienic measures which were then in actual but partial operation, goes on to say :—

"It may be affirmed, without great risk of exaggeration, that it is possible to reduce the annual deaths in England and Wales by 30,000, and to increase the vigour (may I not add the industry and wealth ?) of the population in an equal proportion ; for diseases are the iron index of misery, which recedes before strength, health, and happiness, as the mortality declines."

Thus, although the science of vital statistics, upon which all scientific sanitation is based, was then in its infancy, Dr. Farr foretold the important results which would flow from a registration of the causes of death.

Defective Sanitary Condition of the People at the Beginning of the Queen's Reign.

The year 1838 was the first complete year of registration.

The first report of the Registrar-General brought forward the sanitary condition of different parts of the country, and of different classes of the population. Disease was as prevalent amongst the labouring population in rural villages as it was in the most crowded and filthy districts in towns, and, on the motion of the Bishop of London, the House of Lords, in August, 1839, presented an address to the Queen, begging her to direct an inquiry into this prevalence of disease. From this period may be said to date that great social and sanitary movement which has tended so largely to ameliorate the moral as well as the physical condition of the people of this island, and which forms one of the most prominent features of the Queen's reign.

The Poor-law Commissioners were directed to report upon the condition of the labouring classes ; and the direct evidence of much preventible disease, which the records of disease and death furnished from all parts of the country, formed the basis on which the Commission founded their recommendations.

In towns, the people were crowded in courts and alleys ; they swarmed in cellars which were neither ventilated nor drained.

In 1837, it was calculated that one-tenth of the population of Manchester, and one-seventh of the population of Liverpool, lived in cellars. The following is a description of a court in Manchester, with its accompaniment of cellar accommodation :—

"It was unpaved ; down the middle a gutter found its way, every now and then forming pools in the holes with which the street abounded. Women from their doors tossed household slops of every description into the gutter, which ran into the nearest pool, which overflowed and stagnated.

"Steps from this filthy court led down to a small area, where a person standing would have his head one foot below the level of the street, and might, without the least motion of his body, at the same time touch the windows of the cellar and the damp, foul wall right opposite. You went down one step from this foul area into the cellar, in which a family of human beings lived.

"It was very dark inside. The window panes, many of them, were broken and stopped with rags, which was reason enough for the dusky light which prevailed at mid-day.

"The smell was so fetid as to almost knock down the incomer.

"The children lay on the damp, nay, wet, brick floor through which the stagnant moisture of the street oozed up."

The dead were buried in overcrowded churches, chapels, and churchyards in the middle of towns. In 1845, a chapel in the immediate neighbourhood of Lincoln's-inn-fields was used as a school-room in the day time, and a dancing saloon at night ; in the cellars underneath this chapel 10,000 bodies had been interred in the seventeen years ending 1840, the burials were still continuing, and the old coffins were removed through a contiguous sewer to make room for new ones.

The rural districts were no better. The condition of rural cottages may be gathered from a graphic account by Sir H. Acland. The village school was a room 11 ft. by 7 ft., where 13 children were being taught lace-making. They slept in a room 11 ft. by 12 ft., the beds touching, so that there was no space to stand between them. Next door, a cottage, occupied by three men, had as its only furniture a log of wood to sit on ; the bedroom was reached by a short ladder with six rungs, of which two were gone ; the only bedding was some straw, slept on till it was as small as chaff, the only bed-clothes some sacking.

An agent, who managed several large estates in the Midland Counties, remarked of the cottages of those days :—

"I ever think of the squalid misery of poor, wretched, woebegone men and women, and, above all, of children, from whom happiness of any wholesome kind seemed hopelessly gone; the hungry, half-starved families crowding round a miserable bowl of potatoes, often without even a bit of bacon, and thankful indeed to get it, supplemented with a supply of bread and weak tea."

In the towns this condition of things arose from the great increase of population which had been taking place for some years previously, coincident with the rapid expansion of our trade and manufactures, coupled with the absence of legislative provisions to meet the new exigences which had arisen, and with which the older laws, in consequence of that increase, were unable to cope.

But there were other active causes. For instance, the Commissioners state that parochial administration operated mischievously in degrading the habitations of the labouring classes, and in checking tendencies to improvement. Owners of cottage tenements, when acting as administrators of the Poor-law, got their own tenants excused from the payment of rates, and obtained higher rents from the occupiers in proportion to the exemption.

The operation was as follows:—The legal ground for exemption was, not the value of the tenement, but the destitution or inability of the tenant to pay; but inasmuch as the occupation of a well-conditioned tenement, or a tenement in advance of the others, would be popularly considered *primâ facie* evidence of ability to pay rates, the cottage speculator would not incur the expenses of improvement or repair, because it would be evidence against the exemption by which he would gain. The exempted tenements were of a very inferior order. The rents collected for them were exorbitant, and such as ought to have ensured tenements of a higher quality.

In some cases cottage tenements were owned by the parish, where the inmates were not only excused from the payment of rates, but from the payment of rents. To the parish the property yielded nothing; the pauper lived on in filth and wretchedness, in a hovel of which he did not dare to complain, because he held it by sufferance.

Under the then new Poor-law the Commissioners had power to authorise their sale, and in the cases where the parish property was sold, a vast improvement in the external appearance of the cottages took place, and the depressing effect of the exemption was well illustrated by the effect of the withdrawal.

The depression of the tenement depressed the habits and condition of the inhabitants. Thus, if a woman who had been brought up cleanly and thrifty and well conditioned, married and went to live in these wretched dwellings, she became slatternly and drunken. The worst of it was, that the labourer evidently had the means of paying for a more decent dwelling, because the exemptions from rates were charged to him as so much extra rent. But he could not obtain improvements in his his house, water supply, or drainage, or in the paving of the surface round his house, or the removal of refuse, by his own unaided efforts; and there existed then no means by which either his landlord or the community could be compelled to perform these services.

In speaking of the insanitary condition of houses, we must not forget the effect of the window tax. This tax had been established for 150 years. Air and sunshine are the first requirements of healthy dwellings, and the window tax induced every builder to shut out the sun and exclude the air, so that poor men were unable to afford the luxury of adequate windows for their dwelling rooms, or of any windows for their closets. Darkness and dirt go hand in hand, and in the class of houses above the cottages, darkness and want of ventilation were much fostered by the window tax. This tax was not abolished till 1851.

Insufficiency of Sanitary Administration at the Beginning of the Queen's Reign.

The laws then in force for the protection of public health were mainly based upon the common law that no man should do anything by which the health or personal safety or the convenience of the subject might be endangered or affected injuriously.

A common nuisance is defined to be an offence against the public, "either by doing a thing which tends to the annoyance of all the King's subjects, or by neglecting to do a thing which the common good requires." And under this definition, overcrowding was held to be a nuisance; for it was held to be a common nuisance, and indictable, to divide a messuage in a town for poor people to inhabit, by which it would be more dangerous in time of infection.

It will be opportune here to mention, in reference to the overcrowding of cottages, that the statute of the 31st of Eliz. c. 7, provided that there should not be more families or households than one

dwelling or inhabiting in any one cottage. The statute moreover provided that no cottage should for the future be built without four acres, at the least, of land attached to it. But this provision did not extend to cottages in towns, or for mineral works, navigation, sheep-cotes, &c. The obligation for attaching the four acres of land impeded the erection of new tenements, and occasioned inconvenience, and led to the repeal of the whole statute, by the 15th Geo. III., c. 32.

At the commencement of the Queen's reign, drainage over the whole country was provided for by various Commissions of Sewers. Their duty was limited to causing "to be made, corrected, or repaired, amended, put down or reformed, as the case shall require, walls, ditches, banks, gutters, sewers, gates, cullices, bridges, streams, and other defences by the coasts of the sea and marsh ground."

The Highway Acts provided for road cleansing and road structure; and there was a law for cleansing of ditches, which forbade throwing offal and foul refuse into the ditches which might lead to the pollution of streams.

The most important, perhaps, because the most cheap and accessible, authority for enforcing the execution of the law for the protection of the subject against nuisances, and for punishing particular violations of it, was vested in the Courts Leet. The juries, commonly called "annoyance juries," impanelled to serve on courts leet in towns, perambulated their districts to judge of nuisances upon the view; but the Commissioners reported that, with all this legal strength, there was scarcely one town in England found in a low sanitary condition, or scarcely one village marked as the abode of fever, that did not present an example of standing violations of the law, and of the infliction of public and common as well as of private injuries, the tenements overcrowded, streets replete with injurious nuisances, the air rendered noisome by these and by the smoke from factory chimneys, and the streams of pure water polluted.

As regards smoke, most of the then modern private Acts contained penalties on gas companies, prohibiting their washings to contaminate streams, or using for steam-engines furnaces which did not consume their own smoke. The general statute, 1 and 2 Geo. IV., c. 41, empowered the Court to award costs to the prosecutor of those who use such furnaces; but the duty of informing was not placed on public officers, and private individuals were unwilling to become informers.

The provision of pure water, and the disposal of the water after it had been fouled, had scarcely been thought about. No doubt in London, and in some large towns, water was provided by public companies or by the corporation; but in almost every country town the water supply was defective. Even in Bath, where the corporation supplied a large part of the town, it was mentioned as an illustration of the habits of many of the working population in that city, that—

"A man had to fetch water from one of the public pumps in Bath, the distance from his house being about a quarter of a mile. 'It is as valuable,' he said, 'as strong beer. We can't use it for cooking, or anything of that sort, but only for drinking and tea.' 'Then where do you get water for cooking and washing?' 'Why, from the river. But it is muddy, and often stinks bad, because all the filth is carried there.' 'Do you then prefer to cook your victuals in water which is muddy and stinks to walking a quarter of a mile to fetch it from the pump?' 'We can't help ourselves, you know. We could not go all that way for it.'"

Sir Henry Acland describes the water supply of a village in Oxfordshire, some thirty-five years ago, as a pit in the middle of a field a quarter of a mile from the village, the sides of which were trodden down by cattle who went to drink, and deposited the filth all round.

The report on the sanitary condition of the labouring classes states that it was difficult to conceive the great extent to which the labouring classes are subjected to privations, not only of water for the purpose of ablution, house cleansing, and sewerage, but of wholesome water for drinking and culinary purposes. Whilst, however, the water supply was insufficient even in London, on the other hand, the necessity for providing means for getting rid of the fouled water was generally ignored.

It is stated, in the report of 1842, that the courts inhabited by the poorer classes in towns are generally not flagged; they are paved with a sort of pebbles; they are always wet and dirty. The people, having no convenience in their houses for getting rid of waste water, throw it down at the doors; that scarcely one house for the working classes will be found in which there is such a thing as a sink for getting rid of the water. It mentions, in a typical case, that where in one locality a large sewer had recently been made, the landlords are not compelled, and do not go to the expense of making any communication from the courts to the sewer; the courts are as wet and dirty, and in as bad

a condition as they were before the sewer was constructed; and it is added that this miserable accommodation in the wretched courts pays a better per-centage than any other description of property; it pays as much as 20 per cent. in many instances.

With regard to fæcal matter, the general practice had been for each house to have its cesspit, which was emptied at intervals by night men; but in the poor districts the soil was allowed by the occupiers to accumulate for years to avoid the expense of emptying. Within the preceding twenty years water-closets had been introduced into the better class of houses. The refuse from these was generally allowed to flow into the cesspits; but, to avoid the expense of frequent emptying, an overflow was made, where practicable, into sewers or adjacent ditches; in other cases the refuse was turned directly into the sewers, and created a dangerous deposit.

The danger had begun to be noticed long before; for in 1834 one medical witness stated to a Committee of the House of Commons that of all cases of severe typhus that he had seen, eight-tenths were either in houses of which the drains from the sewers were untrapped, or which, being trapped, were situated opposite gully holes; and the report of the Poor-law Commissioners remarks that this recent mode of cleansing adopted in wealthy and newly-built districts by the use of water-closets, which discharge all refuse *at once* from the house through the drain into the sewers, whilst it saves delay, prevents accumulation, and also saves the expense of hand labour; yet has the objection that if much extended it may pollute the water of the river into which the sewers are discharged. They, however, recommend that this danger should be incurred, as a lesser evil than the retention of the refuse in houses; adding that—

"It is possible to remove the refuse in such a mode as to avoid the pollution of the river, and at the same time avoid the culpable waste of this most important manure."

The conditions under which the drains had been constructed were entirely different from those which became necessary with the increase of population. The sewers had been constructed for land drainage, and only with reference to the wants of the immediate locality, so as just to drain it to the nearest outlet, without any reference to any general plan of sewerage. The sewers were generally flat at the bottom, of stone or brick; the joints were not specially water-tight, so that much of the liquid passed into the surrounding soil, and the floor of the sewers was covered with deposit, which had to be removed at much expense by hand, and in many cases the size and form of the sewers were adapted to enable the workmen to enter for cleansing purposes. When new lines of houses were built, new sewers were required for which outlets into the old sewers did not afford sufficient fall, and they then became choked with deposit. The cleansing of streets was not performed with uniformity or rapidity; and the condition of many of the back streets and courts was deplorable. They were not properly paved, and had no conveniences.

The Poor-law Commissioners recommended, in the report already mentioned, that the expensive and slow progress of the removal of the surface refuse of the streets by cartage might be dispensed with, and the whole at once carried away by the mode which is proved, in the case of the refuse of houses, to be the most rapid, cheap, and convenient, namely, by sweeping it at once into the sewers, and discharging it by water. This recommendation was largely adopted.

In order to convey some idea to your minds of the difficulties which would necessarily be caused by turning the street sweepings, which consisted largely of mud from macadamised roads directly into the sewers, I may mention that at the present time in London every effort is made to stop the road material from passing into the sewers by sweeping the streets, and by placing catchpits at the gullies and cleansing them frequently, and that in the metropolis the quantity of dirt from roads and gullies, and of deposits from sewers, removed annually amounts to nearly 1,000,000 tons, and the annual quantitiy in those days cannot have fallen far short of 350,000 tons. The combined effect of turning the street sweepings and the water-closet refuse into sewers, with uneven falls and flat bottoms, naturally added to the deposit, and intensified the evils in such a manner as finally to force on improvements in the construction of the sewers.

The difficulties as to drainage and the removal of refuse were principally entailed by the absence of any legal machinery to enable the inhabitants of a locality to combine for sanitary purposes, and to share the expenditure necessary for improvements.

Another important insanitary condition was caused by the fact that the vagrant population of the kingdom resorted to common lodging-

houses, which were under no sort of supervision, and which were *foci* for the propagation of epidemic disease, as well as of moral depravity. It is, however, noteworthy that at Glasgow legislative power had been obtained to enforce police supervision over these lodging-houses; and as an evidence of the foresight of that municipality, it may be mentioned that the regulations adopted in the borough of Calton, do not practically differ from those in force all over the country at the present day.

Remedies Proposed in the Report of the Poor-law Commissioners of 1839-42.

The general conclusions at which the Poor-law Commissioners arrived in their report on the condition of the working classes were that disease originating in or propagated by means of decomposing refuse and other filth, and damp, close, and overcrowded dwellings, prevailed generally among the working classes in all parts of the kingdom; and that whilst these diseases could be abated by improved sanitary conditions, they were not removed by high wages and abundant food, if sanitary conditions were absent. They also pointed out that owing to the defective water-supply cleanly habits were impossible.

In illustration of the loss caused to the nation by these preventible diseases, they mentioned that out of 43,000 widows and 112,000 destitute orphans relieved from the poor-rates, the greater number had lost their husbands or fathers from preventible diseases; and that the youthful population of either sex brought up in crowded unwholesome dwellings, and under the adverse circumstances described, were deficient in physical strength and moral conduct, and grew up improvident, reckless, and intemperate, caring for nothing but sensual gratification. They pointed out that the expenses of local public works were unequally and unfairly assessed, oppressively and uneconomically collected by separate collections, and wastefully expended by unskilled and irresponsible officers, and that the existing law for the protection of the public health, and the constitutional machinery for its execution, such as the Courts Leet, have fallen into desuetude.

The Commission then went on to state the conditions required for improving the sanitary condition of the labouring classes, which may be summed up as follows:—

1. The provision of drainage, the removal of all refuse from habitations, streets, and roads, and the improvement of supplies of water.

2. That as the expense and annoyance of hand labour or carting was the chief obstacle to the immediate removal of decomposing refuse of towns and habitations, they proposed the use of water and self-acting means of removal by improved and cheaper sewers and drains; adding that refuse when held in suspension in water may be cheaply and innoxiously conveyed to a distance out of towns, and is in the best form to be applied in cultivation, so as to save the fertilising matters and avoid injury by the pollution of natural streams.

3. That for these purposes, as well as for domestic use, better supplies of water are absolutely necessary.

4. That the expense of public drainage, and public supplies of water laid on in houses, and of means of improved cleansing, would be a pecuniary gain, by diminishing the existing charges attendant on sickness and premature mortality.

5. That skilful civil engineers should be employed to devise and construct new local public works, both to protect the ratepayers against inefficiency and waste, and to ensure public confidence that the expediture will be beneficial.

6. That to avoid the oppressiveness and injustice of levying the whole immediate outlay for such works upon persons who have only short interests in the benefits, the expense should be spread over periods coincident with the benefits.

7. That it would be good economy to appoint, in each district, a specially qualified medical officer, independent of private practice, to examine into the means necessary to prevent disease, and to initiate sanitary measures and reclaim the execution of the law.

The report added—

"The removal of noxious physical circumstances, and the promotion of civic, household, and personal cleanliness, are necessary to the improvement of the moral condition of the population; for sound morality and refinement in manners and health are not long found co-existent with filthy habits amongst any class of the community."

This report was thus one of the early fruits of the system of vital statistics which commenced at the accession of the Queen, under the able supervision of our late eminent member, Dr. Farr. The report itself was

drawn up by another eminent member of this Society, Mr. Edwin Chadwick, C.B.

It is a remarkable tribute to the foresight of Mr. Chadwick that, during the last half-century, almost all the sanitary principles laid down in the report have been recognised by the Legislature as necessary to the welfare of the community, and have become matters of ordinary practice. The conclusions of the Poor-law Commissioners, and the general interest awakened in the subject, led to various sanitary investigations, both by Royal Commissions and Committees of the Houses of Parliament.

Sanitary Legislation during the Queen's Reign.

When the Registration Act came into operation, an epidemic of small-pox was advancing over this island. It attained its maximum in the spring of 1838, and destroyed 30,819 persons. Dr. Farr mentions that vaccinaton protected a part of the population, but that there is reason to believe that inoculation led to the extension of the epidemic by diffusing the infection artificially. In 1840 and 1841, the first Vaccination Acts were passed. These prohibited inoculation, and empowered the Guardians to provide means for vaccination, and to charge the expense on the rates; and enacted that vaccination was not to be considered parochial relief, thus recognising the fact that the community should bear the cost of measures which are found necessary to secure the public health. It was not, however, till 1853 that vaccination was made compulsory.

The reports of the various Commissions and Committees of Parliament which inquired into the condition of the people showed the great importance of cleanliness of person and clothing to health, and the difficulties which the poor suffered in respect of it; and in 1844 private associations, not only in London, but in Manchester, Liverpool, and other large towns, were formed to encourage cleanliness amongst the working classes by establishing public baths and wash-houses, and lending out pails, brushes, and whitewash to the poor to cleanse their dwellings; and in 1846, the Bishop of London brought in a general Act empowering local authorities to establish public baths and wash-houses, the expense of which was to be defrayed out of the rates.

As regards general sanitary legislation, it is probable that the recommendations in the Poor-law Commissioners' report and in the reports of these several Royal Commissions and Committees of the Houses of Parliament, would have remained long in abeyance had it not happened that the nation was threatened with an epidemic of cholera.

In 1832-3, the cholera had visited our shores and snatched 16,437 victims. Late in 1845 a great epidemic outbreak of cholera proceeded from Cabul and the North-Western Provinces of Hindostan as from a centre, swept over Afghanistan, Persia, and the south-eastern portion of Asiatic Turkey in 1846; it advanced in 1847 into Eastern Europe. In 1848 it nearly decimated the cities and towns of the lower Danube, and passed through Austria into Germany and Hanover. Hamburg was attacked on the 7th September, and within three weeks afterwards the epidemic reached the shores of Britain, where it first appeared in London on the 22nd September, 1848, and in Edinburgh in the beginning of October, 1848.

So long as the insanitary conditions remain, epidemics invariably haunt the same localities, and the first appearance of the cholera in Bermondsey in 1848 was close to the same ditch in which the earliest fatal cases occurred in 1832. The first case of cholera that occurred in the town of Leith took place in the same house and within a few feet of the very spot from whence the previous epidemic of 1832 commenced its course. On its reappearance in 1848 in the town of Pollockshaws, it snatched its first victim from the same room and the very bed in which it broke out in 1832. It did not, however, attain its full intensity until 1849, and it ceased on the 22nd December, 1849. Its progress fully corroborated the report of the Poor-law Commissioners. It attacked those towns and houses which offered to it the best inducements to visit them in their filth, decaying refuse, crowded and dirty population, bad water, damp polluted subsoil, or any other of those conditions which lead to bad health in a population, and which, when cholera is absent, afford an evidence of their existence by the prevalence of scarlet fever, small-pox, typhoid and other fevers, measles, whooping cough, &c. The total number of victims was 53,293.

The near approach of the cholera led Parliament, in 1848, to the conclusion that—

"Further and more effectual provision ought to be made for improving the sanitary condition of towns and populous places in England and Wales, and it is expedient that the supply of water to such towns and places, and the sewerage, drainage, cleansing,

and paving thereof, should, as far as practicable, be placed under one and the same local management and control, subject to general supervision."

An Act was passed creating a General Board of Health. The main feature of this Act was that when the Registrar-General's returns showed that the number of deaths on an average of the preceding seven years exceeded 23 per 1,000, the General Board of Health were empowered to send an inspector to make a public inquiry as to the sewerage, drainage, water supply, burial-grounds, number and sanitary condition of inhabitants, and local sanitary Acts in force; also as to natural drainage areas, the existing local boundaries, and whether others might be advantageously adopted. The General Board were empowered to issue provisional orders, creating a system of local administration by means of Local Boards of Health, consisting partly of municipal authorities and partly of elected members. These Local Boards were empowered to appoint necessary officers, including medical officers of health, surveyors, and inspectors of nuisances. The public sewers were vested in the Local Board, and they were to maintain, cleanse, and regulate the use of sewers. All houses rebuilt were required to be provided with drains approved by the surveyor, and before any new house was commenced the levels of the cellars or lowest floors, and the position and character of the drains or cesspools, was to be approved by the surveyor. The occupation of cellars as dwellings was prohibited. Water-closets or privies, and ash-pits were to be provided to all houses and workshops. The Local Board was also re-required to manage, repair, and clean the streets, and to provide for removal of refuse. They were to abate nuisances, regulate slaughter-houses, register and make bye-laws to regulate common lodging-houses. The local authorities were empowered to provide public recreation-grounds—to provide a water supply, except where a water company would supply on reasonable terms. They were also to provide mortuaries; to obtain power to close burial-grounds which they considered to be unhealthy, and to open new ones.

The Local Boards were empowered to make bye-laws and impose penalties, subject to confirmation by the Secretary of State, and to levy rates, to mortgage the rates, and to borrow from the Public Works Loan Commission. The Act also provided for sewers, wells, pumps, &c., to be made where desired by the inhabitants in parishes containing less than 2,000 persons. The metropolis was exempted from the operation of this Act.

The General Board of Health came into existence in 1848, just before the outbreak of cholera in this country, and it took measures at once to check the disease, and proclaimed the principles upon which the preventive and other measures for meeting the epidemic ought to be conducted. Amongst these measures probably the one which had the greatest effect in promoting subsequently a general feeling of the necessity for sanitary improvements, and which awoke in the nation the needs of moral improvement, was that requiring house-to-house visitation, and the cleansing of the houses and streets, and obtaining an adequate water supply. This brought into notice the neglected condition of the various localities which the local authorities complacently ignored. One of the inspectors of the General Board of Health remarks:—

"I have repeatedly observed that the authorities of one district, whilst admitting that in other places there might be neglect, affirmed that their parish required little or no amendment. It is one of the great difficulties those who are anxious to ameliorate the condition of the poor experience, that a large part of the influential classes of society know personally so little of the localities and dwellings occupied by them. Many instances have occurred, during the late inquiries, in which, even in country towns, individuals among the higher classes, having been induced to visit the more destitute districts, have expressed their surprise that a condition so miserable as that in which they found their poorer neighbours could have a real existence."

These house-to-house visitations, moreover, prominently exposed the moral and material degradation, and the tendency to crime, engendered by the physical evils concentrated in these wretched dwellings.

The following paragraph, from the report of Mr. G. L. Chesterton, places this in a strong point of view:—

"The crowning cause of crime in the metropolis is, however, in my opinion, to be found in the shocking state of the habitations of the poor, their confined and fetid localities, and the consequent necessity for consigning children to the streets for requisite air and exercise. These causes combine to produce a state of frightful demoralisation. The absence of cleanliness, of decency, and of all decorum—the disregard of any needful separation of the sexes—the polluting language and the scenes of profligacy

hourly occurring, all tend to foster idleness and vicious abandonment."

This epidemic also brought into notice the necessity of appointing efficient medical officers to supervise the sanitary condition of the different towns and districts.

It will not be out of place here to remark that Lord Shaftesbury was one of the first members of the General Board of Health, and that to his untiring efforts both in Parliament and out of it, much of the improved social condition of the people during the Queen's reign is undoubtedly due.

Further Acts for regulating the public health were passed in 1858, 1861, and subsequent years; and all their provisions were embodied in a General Act in 1875, from the operation of which the metropolis was exempted. Subsidiary to these may be mentioned the Acts regulating rural water supply, the Artisans' and Labourers' Dwellings Acts, or what have been more recently termed the housing of the working classes, and also Acts for checking the adulteration of food, as well as other Acts relating to the diseases of animals. This general legislation has been largely supplemented by bye-laws issued by local authorities, with the sanction of the Local Government Board, and by means of Local Acts obtained by various towns.

The Act of 1848 initiated the system which subsequent legislation has supplemented, under which many towns and rural districts have borrowed money for and have executed public sanitary works during the last 40 years. The importance of this measure may be gauged by the fact that the money borrowed since that time for sanitary works, and not yet repaid, amounts to over £130,000,000, in addition to very large sums spent out of current rates; and in addition to an enormous private expenditure, which is beyond the reach of calculation, for the reconstruction of house drains. This legislation and expenditure has caused a complete revolution in that branch of engineering science connected with public health, viz., drainage and water supply, and has gradually established it on a scientific basis.

Modern sewerage may be said to date from the introduction of oval forms in sewers, by Mr. Roe and Mr. Phillips,* under the Commissioners of Sewers, in 1845; the construction of impervious clay pipes for smaller drains; the recognition of the necessity that sewers and drains should be water-tight and self-cleansing; and that junctions should be carefully made. Ventilation of the sewers followed a severe outbreak of typhoid fever, consequent upon the construction of a new unventilated sewer at Croydon. In 1849-50, Sir Robert Rawlinson introduced the system of constructing sewers and drains in right lines from point to point, with lamp-holes or manholes at every change of direction or of gradient; this is now the recognised method of construction among all English-speaking races. The reconstruction of the sewers led to a reform in house drainage, of which the leading characteristics are imperviousness of material, free aëration, and facility of inspection at all points.

The disposal of water-carried sewage began by leading to the widespread pollution of our streams and rivers, and the serious injury of the sea beach in many of our seaside health resorts.

The problem was complicated by the doctrine that as the pollution was caused by a vast amount of fertilising matter, large profits might be made out of its removal. But those who made this assertion generally overlooked the fact that the conveyance of the refuse would have to be paid for just like any other work.

The subject has been repeatedly discussed in this hall, but it is far too extensive for me to enter into here. It may, however, be safely assumed that the water supply which is delivered pure into a town need not be passed in a foul state into streams or rivers; and that precipitation of the solid parts in sewage, and passing the liquid through land, are eminently fitted, when properly applied, to produce a purified effluent at a certain cost; consequently, if certain conditions of population and of sewage were always observed, each district could be made self-contained in respect of its sewage just as it can be in respect of its cemetery; and it is probably wiser to spend money raised by rates on removing the solid matter, filtering the liquid through land, and employing labour on the land to produce a certain quantity of food to be sold, rather than to spend the rates in paying interest on a large capital expenditure for works necessary to convey the sewage to a distance, where its value would be entirely lost.

Similarly in regard to water supply, our advance in mechanical skill has facilitated the almost universal introduction of water to houses in towns, by which the habits of the labouring population have been materially altered; and

* Mr. Phillips is at present employed in superintending the reconstruction of the drainage of the Houses of Parliament.

the constant service has led to numerous alterations and improvements. But, with our present population, the question of obtaining purity of supply has assumed a paramount position.

The cholera epidemic first awakened the public to the dangers of impurity; but the continually increasing population on our small island is daily adding to the surface pollution of the country, and compels us to employ the highest science of the chemist, the physiologist, and the engineer which the country affords, both to ascertain the degree of purity and to devise methods of purification. Indeed, next week, one of our most eminent members will read a paper on this subject.

The Metropolis.

Let us now turn from the community generally to the metropolis, which was excluded from the operation of the Sanitary Acts of 1848 and 1875. The population of London was 960,000 in 1801. At the Queen's accession it had more than doubled, and amounted to about 1,900,000. At the present time it is very nearly 4,000,000. The metropolis has, from its situation, all the attributes of a healthy city. It lies in a valley through the centre of which the Thames sweeps from west to east, and the winds rushing over its water afford a continuous supply of fresh air to the middle of the City. But the advantages of this situation had been largely frustrated by the unopposed efforts of the landowners to accumulate the greatest possible number of houses on the least possible space, by which the free circulation of air was impeded in some districts, and the families of artisans were crowded in small, low, close rooms, without space for the safe retention of refuse; and there was no adequate machinery for its rapid removal.

London is now undoubtedly the finest capital in the world. It was far from being so at the beginning the Queen's reign. The Houses of Parliament were not completed. Buckingham-palace consisted of a centre and two wings, whilst the Marble Arch, now at the corner of Oxford-street, stood like a sentry box in front. Between Piccadilly and Covent-garden there was a network of narrow alleys and streets, and dense masses of population were crowded together in various parts of London in what were termed "Rookeries," where it was dangerous to penetrate. The City streets were narrow and crowded. Smithfield-market, filled with thousands of animals, formed an impassable barrier between east and west on most mornings.

Beyond Knightsbridge were fields and villas, Kensington, Hampstead, and Dulwich, were detached villages. Norwood and Sydenham had barely come into existence.

Open privies, cesspools, and untrapped drains, were spread over the whole of the metropolis, poisoning the surrounding atmosphere with their volatile exhalations.

In the poorer districts, the back yards of the houses were dirty, sodden, and ill-paved; the only attempt made at paving was often by means of loose, broken pieces of stones or bricks; the holes in which they were placed became the receptacles of foul water, defying all attempts at cleanliness.

The absence of dustbins was very general; one corner of a small yard generally served for the purpose of depositing house refuse, which was often allowed to accumulate for weeks, or even months.

There were deplorable deficiencies in the sewerage. The drainage found its way through badly-formed, leaky drains into the old water courses, and thence to the river; the sewage was floated up and down by the tide in the heart of London, until it was deposited on the shore at low water in fetid banks which covered the foreshore from Blackfriars to Battersea.

Before the Queen's accession, some improvements had been commenced, and others had been projected; but the more pressing of the then requirements are summed up in the following extract from Dr. Farr's report to the Registrar-General on the death causes of 1838:—

"The careful exclusion of all unnecessary animal and vegetable matter; the immediate removal of all residual products; and the dilution of inevitable exhalations. The dead should no longer be buried where they are surrounded by crowded dwellings. Unwholesome manufactories should be excluded from densely peopled districts, and there is assuredly no reason why thousands of cattle, sheep, horses, animals of every kind—sometimes affected with epizootic diseases—should be gathered together in market places within the City, or slaughtered in houses where the blood and offal can never be effectually removed."

Dr. Farr remarks that this unsatisfactory state of things was due, in no small degree, to imperfect laws, or to the machinery by which the laws were worked. Outside the City, London had no municipal government; it was an aggegation of parishes, each governed by its

own vestry. The streams and sewers were controlled by the Commissioners of Sewers, formed originally for purposes of land drainage. There was no accurate map of London or of its levels. The inconvenience of the divided jurisdiction in respect of roads had been felt earlier, and the metropolitan roads had been united under a special Commission some years before. There was no general rating for metropolitan improvements. These improvements were made partly at the expense of the Crown and partly out of funds voted by Parliament, in which case the money was generally borrowed on the security of coal and wine dues. The work was done under the control of the Commissioners of Woods and Forests. Regent-street, with Waterloo-place, had been formed some twenty years previously under His Majesty George IV. when Regent. Victoria and Battersea parks were formed early in the Queen's reign, also Coventry-street, and many other streets which it is unnecessary to enumerate.

It is curious to note that, in 1841, much of the land for Victoria-park was bought out of money obtained in 1827 by the Commissioners of Woods and Forests from the sale of York-house, St. James's, to the Marquis of Stafford (created Duke of Sutherland in 1833).

One of the early effects on the metropolis of the report of the Poor Law Commission was a Metropolitan Building Act for improvement of drainage, and for securing a sufficient width of streets and alleys, and due ventilation of buildings, and to regulate the construction of buildings, authorising the vestries to appoint district surveyors.

In 1846, a new Commission of Sewers was formed, and charged with the duty of revising the metropolitan drainage. The Commissioners applied for an Ordnance survey of the metropolis, which was commenced in 1847.

The water supply of London was furnished by water companies, who trenched upon each other's districts. Its volume may be assumed, at the Queen's accession, to have been about 36,000,000 gallons per twenty-four hours. It was estimated by Mr. Wicksteed, in 1845, at 45,000,000 gallons. Some was derived from the tidal part of the Thames, and was more or less filtered; but, from its doubtful purity, pumps in surface wells, often adjacent to churchyards, were frequently preferred for drinking water. In many of the courts and smaller streets water was obtained only from a small stand-pipe, where the water was turned on for an hour or less daily, when the inhabitants stood around waiting with whatever vessels they might have at hand for their turn to procure a portion of a miserably scanty supply, which was then stored for use in probably the only room occupied by a whole family. Amongst the poorer classes, almost the only receptacles that existed were wooden butts, frequently in a state of decay, and, as they were for the most part without covers, the water was placed under favourable circumstances for the reception of dirt and refuse and for the development of animal and vegetable growths.

After the cholera epidemic, the question of the purity and quantity of the water supply attracted notice, and in 1852, Parliament passed an Act forbidding the supply of water from the tidal part of the Thames or its tributaries, and requiring all river water to be filtered and to be kept covered after filtration; also requiring a constant service when demanded by four-fifths of the houses in a district. In 1858, the average daily supply had risen to 75,000,000 gallons. In 1871, another general Act was passed, to make further provisions for securing to the Metropolis a constant supply of pure water; this Act defined the sources of supply of the several companies, and required, amongst other matters, efficient filtration, and the application of tests of purity.

The amount of water delivered into London by the water companies for September last was 178,196,597 gallons in twenty-four hours, of which about 90,000,000 gallons came from the Thames above Teddington Lock; its purity is ascertained by continual analysis; and it may now be said that the water supplied to London rivals that of any other city in purity.

It was not till 1852 that the Secretary of State was authorised to prohibit burials within the metropolis.

A new era in metropolitan sanitation was inaugurated in 1855. In that year the Metropolitan Board of Works was created. In this body was vested the main drainage of the metropolis, but the charge of the subsidiary parish sewers was left to the vestries, who were also charged with the care of the streets and roads, the Metropolitan Roads Commission being abolished, and all duties of lighting, control of removal of refuse, &c., were placed on the vestries.

Thus the formation of this new Board was somewhat of a retrogade movement, because the concentration of functions, which had been commenced under the Metropolitan Roads Commission and Metropolitan Sewers Commis-

sion, instead of being strengthened in the new Board, was abandoned, and something approaching chaos was introduced. This Board has, however, by degrees had remitted to it the care of London improvements, and certain other general municipal functions, as well as power to levy general rates. The City retained its individuality, excepting as to the main sewers, and effected improvements and opened out thoroughfares in the part under its jurisdiction. The improvements in the other parts of London are mainly due to the action of the Metropolitan Board of Works. Great alterations have taken place in our thoroughfares; indeed, Regent-street is the only important thoroughfare which has not undergone an almost complete transformation during the Queen's reign. Smithfield Market for live cattle, has been abolished. Many of those large tracts of London which were occupied by dwellings of the most wretched description, are now traversed by wide thoroughfares, and covered by artisans' dwellings erected by private enterprise. But there is no diminution of the rate at which the vast aggregation of population in London still continues to progress, and, unfortunately, many of the wretched crowded dwellings still remain, where those born in close rooms, brought up in narrow streets, and early made familiar with vice, are deteriorated in physique, and grow poorer from inability to work.

A recent writer in the *Fortnightly Review* says of our prospects:—"The poorer quarters will become poorer, the sights of squalor, misery, and hunger more painful, the cry of the poor more bitter." This is an evil we have to meet and overcome.

Although in respect of the housing of the working classes so much remains to be done, we have results to show that much sanitary improvement has been achieved. We can congratulate ourselves that, in the place of the mud banks, which occupied the foreshore of the river in the heart of London, embankments extending from Chelsea to Blackfriars, and from Vauxhall to Westminster, form the finest roadways in the world; and that the sewage is removed from the heart of London by means of vast works.

The reconstruction of the drains, the removal of the sewage from the midst of the population, the opening out of thoroughfares so as to admit ventilation into crowded districts, have all tended to improve the sanitary condition of London.

I have here some interesting tables (p. 18, *et seq.*), prepared for me by the kindness of Mr. A. J. Mundy, of the Registrar-General's Office, which show the remarkable sanitary results of these various efforts. The death-rate of London in the five years 1838-42 was 25·57 per 1000. In the five years 1880-84 it was 21·01 per 1000; and the deaths from zymotic diseases, which in the decade 1841-50 had averaged annually 5·29 per 1000, were reduced in the years 1880-84 to 3·4 per 1000. If, however, we assume that there had been no change in sanitary conditions, and therefore that the death-rate had gone on increasing according to Dr. Farr's formula of increase due to density of population when the sanitary conditions remain unchanged, the death-rate of 1880-84 would have averaged 26·62 per 1000; that is, a saving of 5·61 per 1000 has been effected by sanitary measures.

If upon this basis we compare the saving in life which has resulted from sanitary improvements at different periods since 1838-42, we find that it amounted to an annual saving of 4,604 lives during 1860-70; of 13,929 lives annually during 1870-80; and of 21,847 lives annually between 1880-84. The main drainage works were commenced about 1860, and terminated in 1878, and the increase in the saving of life in these consecutive periods may to some extent be taken as a gauge of the effect of the gradual construction and completion of these works. No doubt this London death-rate is far too high, and is an evidence that insanitary conditions still prevail all round us, that the housing of the working classes is still far from satisfactory, and that we are too careless about infectious disease. The Metropolitan Board of Works has never had a clear field for municipal action; yet when we compare the present condition of London with what it was at the Queen's accession, the Metropolitan Board of Works, in spite of the disadvantages of its constitution, will have a grand record to show, in the Jubilee year of the Queen's reign, of metropolitan improvements and metropolitan sanitation.

General Results of the Sanitary Legislation on the Well-being of the People.

The main principle which guided public administration, both before and during the earlier years of the Queen's reign, may be said to have been that of non-interference, and of allowing free competition to prevail; although, no doubt, some efforts had been pre-

TABLE A.

Mortality of England and Wales and of London compared with the probable mortality had no sanitary improvement been effected, allowing for increased density of Population.

		England and Wales.	London.
Area in square miles		58,186	118
Mean population	1841-50	16,920,879	2,155,327
	1851-60	18,996,916	2,583,112
	1861-70	21,389,245	3,029,125
	1871-80	24,343,348	3,535,372
Mean density of population—persons to one square mile	1841-50	291	—
	1851-60	326	21,891
	1861-70	368	25,671
	1871-80	418	29,961
Average annual mortality per 1,000 population	1841-50	22·28	24·22
	1851-60	22·17	23·62
	1861-70	22 42	24·31
	1871-80	21·27	22·37
Mean annual mortality, calculated from density of population*	1841-50	22·27	—
	1851-60	22·58	—
	1861-70	22·91	25·83
	1871-80	23·26	26·31
Saving of lives annually through sanitary improvements	1841-50	(Loss) —169	—
	1851-60	7,789	—
	1861-70	10,481	4,604
	1871-80	48,443	13,929

NOTE.—The area of London was enlarged during the decade 1841-50 (in 1844 and 1847) by the inclusion of Wandsworth, Lewisham, and Hampstead. As this had the effect of reducing the number of persons to a square mile in the decade 1851-60 below the standard of 1838-42, no estimate of mortality from density in this period is given.

* The basis of calculation is the density of population in the five years 1838-42, with the mortality in the same period.

viously made to regulate the labour of females and children in Factory Acts.

The practical application of the knowledge derived from the Registrar General's statistics led to further investigation in particular cases by such men as Dr. Simon, Dr. Buchanan, Sir Robert Rawlinson, and others, and gradually caused a reaction from what may be called the *laissez faire* system, to the spread of opinion in the direction of control over individual action in the interest of the community generally; and the result was the enactment of the successive laws for regulating the sanitary condition of the people, which I have enumerated above.

This large amount of legislation is practically little more than the interpretation required by the increase of population, and by the complicated exigencies of modern life, of the common law maxims, *Prohibetur ne quis faciet in suo quod nocere possit alieno;* and *sic utere tuo ut alienum non lædas:* that is to say, no man shall do anything by which his neighbour may be injuriously affected, and each person must so use his property and his rights as not to harm any one else.

This common law doctrine had become practically obsolete, because there was no machinery in existence to enforce it; and the present generation inherited a legacy of misery

TABLE B.

Comparative Mortality of England and Wales, and of London, in the two quinquenniads 1838-42 *and* 1880-4.

	England and Wales.		London.	
	1838-42.	1880-4.	1838-42.	1880-4.
Average Population	15,718,517	26,418,616	1,840,865	3,894,261
Total Deaths	1,734,797	2,591,038	235,400	409,037
Deaths from: —				
Small-pox	44,916	8,254	7,099	4,302
Measles	42,413	52,992	6,022	11,107
Scarlet fever and Diphtheria	62,911	88,116	7,864	14,617
Whooping-cough	39,594	61,698	8,194	14,925
Fever	82,665	39,356	9,494	5,385
Diarrhœa and Dysentery	20,062	104,251	2,873	15,492
Cholera	3,490	2,662	257	553
The foregoing zymotic diseases	296,051	357,329	41,803	66,381
Average Annual Mortality per 100,000 population from: —				
All causes	2,207	1,962	2,557	2,101
Small-pox	57	6	77	22
Measles	54	40	65	57
Scarlet fever and Diphtheria	80	67	86	75
Whooping-cough	51	47	89	77
Fever	105	30	103	28
Diarrhœa and Dysentery	26	79	31	79
Cholera	4	2	3	3
The foregoing zymotic diseases	377	271	454	341

NOTE.—The London of 1838-42 was not, in extent, precisely that of 1880-4, inasmuch as Wandsworth, Lewisham, and Hampstead were not included in "Registration London" in the earlier period.

amongst the poorer classes, owing to the absence of regulations in the building of houses as the towns increased in size, absence of water supply and drainage, and other matters which I have mentioned.

Mr. Mundy's calculations show us what have been the general results of the sanitary improvement of the nation. The death rate of 1838-42 for England and Wales was 22·07 per 1,000; that of 1880-84 was 19·62 per 1,000; and the deaths from zymotic disease, which averaged 4·52 per 1000 in the decade 1841-50, were reduced to 2·71 per 1000 in the years 1880-84. It is, however, curious to note that the improvement in urban districts does not appear to have kept pace with that in rural districts, for it appears from Table E that whilst the deaths from zymotic disease in certain urban districts have declined from 5·89 per 1,000 in the decade 1851-60 to 5·12 per 1,000 in the decade 1871-80, the deaths from zymotic disease in rural districts in the same interval have declined from 2·77 to 1 67 per 1,000.

In order to form an estimate of the saving of life due to sanitary measures, we may assume that sanitation remained in abeyance, and calculate what the death-rate, according to Dr. Farr's formula, would have been in consequence of increased density of population, and compare that with the actual death rate; upon this assumption we find that the sanitary improvements only began to tell after the cholera epidemic of 1848-9. In the decade 1841-50, indeed, it appears that the death-rate was actually larger than that due to the increased density of population. But in the following decade, the sanitary improvements began to produce their effect, and this effect has gradually increased. In the decade 1850-60, the annual average saving of lives in England and Wales from sanitary improve-

TABLE C.

Mortality in England and Wales and in London, 1838-42 and 1880-4, contrasted with the probable mortality in the latter period, calculated from density of population—assuming that no sanitary improvemens had been effected in the interval.

	England and Wales.		London.	
	1838-42.	1880-4.	1838-42.	1880-4.
Area in square miles	58,186	58,186	78	118
Average population	15,718,517	26,418,616	1,840,865	3,894,261
Average density, persons to one square mile	270	454	23,601	33,002
Average annual mortality per 1,000 population	22·07	19·62	25·57	21·01
Average annual mortality calculated* from density	..	23·49	..	26·62
Excess of calculated over actual mortality	..	3·87	..	5·61
Saving in lives annually through sanitary improvements	..	102,240	..	21,847

NOTE.—The London of 1838-42 was not, in extent, precisely that of 1880-4, inasmuch as Wandsworth' Lewisham, and Hampstead were not included in "Registration London" in the earlier period.

* The mortality was calculated from the formula—

$$m' = m \left(\frac{D'}{D}\right)^{0·11998.}$$

which Dr. Farr found to express approximately the relative increase of density and mortality (see "Supplement to Registrar-General's 35th Annual Report," pp. xxiv., clviii). In this instance, m is the symbol for the average annual mortality in the 5 years 1838-42, and D the mean density of population in the same period, while D' represents the mean density in the 5 years 1880-4, and m' the calculated mortality in this quinquennium.

ments was 7,789; in the decade 1860-70, it rose to 10,481; in the decade 1870-80, it was 48,443; and in the five years 1880-84, the average annual number of lives saved by sanitary improvements have been 102,240.

The present social condition of the people affords an equally striking evidence of general improvement. Food and clothing are cheap; the construction of streets and new buildings in our towns are regulated; houses are improved; overcrowding and cellar dwellings are prohibited; the common lodging-houses are controlled. Petroleum affords a brilliant light to the poor in country districts which are beyond the reach of gas or of the electric light, and who were formerly dependent on rushlights. Water supply is rarely deficient; removal of refuse is enforced. But there remains much still to be done. Numbers of the people are still crowded in wretched dwellings; our rivers are polluted and subject to floods; our infectious diseases are not properly cared for.

The main feature of the legislation of the past half century is the recognition of the principle that when large numbers are congregated together in communities, the duty of preventing injury from this aggregation rests on the community; and if this principle is duly acted on, if in all aggregations of population free circulation of air is encouraged by preventing the crowding together of buildings; if refuse is immediately disposed of, so as to cause no injury to anyone; if pure water be provided; if we isolate infectious diseases; and above all, if we are fortunate enough to retain the blessing of cheap food and clothing, we shall not transmit to our posterity a similar legacy of misery to that which we inherited.

SANITARY IMPROVEMENT OF THE ARMY AND OF INDIA.

In this brief summary I have only been able to sketch out the sanitary conditions of the civil population in this island. But that sketch leaves untouched some of the most important features in the progress of sanitation during the Queen's reign.

In the army, between 1844 and 1854, the death-rate of the British soldiers, who were selected lives, was 17 or 18 per 1,000, during peace, at home stations, as compared with a calculated death-rate of 8 per 1,000 of the lives

TABLE D.

Mortality in England and Wales and in London from the principal Zymotic Diseases, 1841-80.

	1841-50.		1851-60.		1861-70.		1871-80.	
	England and Wales.*	London.	England and Wales.	London.	England and Wales.	London.	England and Wales.	London.
Mean population	16,984,116	2,103,487	18,996,916	2,583,112	21,389,245	3,029,125	24,343,348	3,53[illegible],372
Deaths from—								
Small-pox	29,522	8,416	42,071	7,150	34,786	8,347	57,422	15,539
Measles	43,733	13,011	78,211	13,766	94,099	17,338	91,948	17,947
Scarlet fever } Diphtheria	88,660	18,314	166,432	24,294	207,867	34,391	174,232	21,247
Diphtheria			20,723	2,023	39,454	5,323	29,426	4,319
Whooping-cough	49,704	18,079	95,624	22,497	112,800	26,550	124,532	48,728
Fever	117,791	20,890	172,458	21,871	189,285	26,850	118,039	13,002
Diarhœa, dysentery, and cholera	131 599	32,514	205,172	39,248	230,201	38,981	227,656	34,496
The foregoing zymotic diseases	461,009	111,224	780,691	130,849	908,492	157,780	823,255	135,278
Average annual mortality per 100,000 population from—								
Small-pox	29	40	22	28	16	28	24	44
Measles	43	62	41	53	44	57	38	51
Scarlet fever } Diphtheria	87	87	88	94	97	113	72	60
Diphtheria			11	8	18	18	12	12
Whooping-cough	49	86	50	87	53	88	51	81
Fever	115	99	91	85	89	89	48	37
Diarrhœa, dysentery, and cholera	129	155	108	152	108	128	93	98
The foregoing zymotic diseases	**452**	**529**	**411**	**507**	**425**	**521**	**338**	**383**
ALL CAUSES	2,283	2,422	2,217	2,362	2,242	2,431	2,127	2,237

* The figures in this column relate to the six years 1841-2, 1847-50.

of the civil population at similar ages. After the Crimean war, the exertions of Sidney Herbert, Miss Florence Nightingale, Dr. Sutherland, and others, led to great improvements in the lodging, food, dress, and general management of the soldier, and during 1885 the army death-rate at home stations did not exceed 5 per 1,000; this means the annual saving in peace time of three whole regiments. Considering that the soldier's life is carefully selected, and that his period of service is shortened, this death-rate in peace time is still too high.

In the British army in India, before the Crimean war, a death-rate prevailed of 60 and 70 per 1,000; that is to say, that with an army of 60,000 men, between 3,000 and 4,000 men had to be sent out yearly in peace time to replace the loss. This, by means of improved attention to the soldiers' lodging, clothing, food, and other matters, has been reduced to between 15 and 17 per 1,000. Moreover, the inquiry into the health and the condition of the British army in India led to a consideration of the defective sanitary condition of the civil population, and was followed by the creation of a sanitary organisation throughout the Queen's empire in India, which is leading to a vast improvement in the sanitary condition of the native population.

CONCLUSION.

The changes which have taken place in the last fifty years in every branch of life, social, political, and commercial, will make the reign of Queen Victoria ever stand out as an important historical epoch. In respect of sanitation, she found that the old systems, designed to regulate the sanitary condition of the people in simpler times for a small population, no longer met the exigencies of our crowded cities and more complicated habits of life.

If time had permitted, I should have liked to dwell on the economic and social considera-

TABLE E.

Mortality from all Causes, and from the principal Zymotic Diseases, in certain Urban and Rural Districts of England, 1851-80.*

	Urban Registration Districts,			Rural Registration Districts.		
	1851-60.	1861-70.	1871-80.	1851-60.	1861-70.	1871-80.
Mean Population	2,058,415	2,418,073	2,788,933	510,768	513,645	518,490
Deaths from :—						
All causes	549,232	667,740	733,094	98,263	94,193	87,993
Small-pox	4,952	4,057	6,536	347	293	246
Measles	13,557	17,319	18,312	1,153	1,075	715
Scarlet fever	28,423	34,088	33,280	2,652	3,085	1,561
Diphtheria	1,082	3,854	3,125	1,087	1,082	628
Whooping-cough	14,708	18,791	19,110	1,656	1,636	1,535
Fever	21,649	34,009	19,464	4,548	3,246	1,734
Diarrhœa, dysentery, cholera	36,981	45,532	42,891	2,684	2,471	2,256
The foregoing zymotic diseases	121,352	157,650	142,718	14,127	12,888	8,675
Average Annual Mortality per 100,000 population, from :—						
All causes	2,668	2,761	2,629	1,924	1,834	1,697
Small-pox	24	17	23	7	6	5
Measles	66	72	66	23	21	14
Scarlet fever	138	141	119	52	60	30
Diphtheria	5	16	11	21	21	12
Whooping-cough	71	78	69	32	32	30
Fever	105	140	70	89	63	33
Diarrhœa, dysentry, cholera	180	188	154	53	48	43
The foregoing zymotic diseases	589	652	512	277	251	167

* The urban districts comprise the whole of Lancashire, excepting the districts in which the area to each person in 1871-80 exceeded one acre. The rural districts are selected from the counties of Hants, Herts, Essex, Wilts, Dorset, and Lincoln and contain no towns of any importance in respect of population.

tions involved in the saving of life which has thus been effected in every branch of the population, and in every part of the Queen's empire. It implies the diminution of disease, with its consequent pain and misery, and a raised physical condition of the people. It has carried with it a higher social standard and improved morality, and has diffused a large measure of happiness throughout the nation.

Amongst those who have largely influenced this great sanitary and social movement have been the Presidents of this Society. H.R.H. the Prince Consort, who was your President from 1843 until his deeply lamented death, was one of the early pioneers of sanitary progress. He was always seeking what would improve the condition of the working classes, and he used his whole influence to push forward the movement for improving the health of the army.

At the Exhibition of 1851, his Royal Highness caused to be erected model houses for four families in Hyde Park, adjoining the Cavalry Barracks, with the view of—

"Conveying practical information calculated to promote the much needed improvement of the dwellings of the working classes, and also of stimulating visitors to the Exhibition, whose position and circumstances may enable them to carry out similar undertakings, and thus without pecuniary sacrifice, permanently to benefit those who are greatly dependent on others for their home and family comforts."

Of the efforts to promote the health and the well-being of the people by your present Presi-

dent, H.R.H. the Prince of Wales, it is almost unnecessary for me to speak here, in the face of the fact that he initiated and carried through with such marked success the Exhibitions of Health and Education, the Inventions Exhibition, and, lastly, that great Exhibition which has this year helped to cement the feeling of brotherhood between us and our Colonial Empire, and which has been visited by nearly one-fifth of the inhabitants of this island; I would only remind you that H.R.H. was the active chairman of the Royal Commission on the Housing of the Working Classes.

The interest in sanitary progress of H.R.H. the Duke of Albany led him to become President of the Parkes Museum. But the mainspring of the deep interest which the members of the Royal Family have exhibited in promoting the well being of the people lies in the Queen herself. If the wife and mother had not been what she is, neither could the husband or sons have been the benefactors of the people which they have been. The Queen may have suffered much from private grief, and endured much from public cares, but on entering the jubilee year of her reign she will be able to feel that she has not laboured in vain. She may feel satisfaction at having increased by added provinces that legacy of empire which she received from her predecessors. But she will have the greater satisfaction of feeling that the provinces which she has added are the smallest part of the triumphs of her reign. Those triumphs are better summed up in the million of lives which have been saved, the consequent vast amount of disease which has been avoided, the physical health which has been promoted, the education which has been developed. Indeed, the chief feature of the Queen's beneficent reign has been the improvement that it has produced in the morality, the well-being, that is to say, the happiness of her people.

The following letter from Mr. E. Chadwick, C.B., has been received :—

Nov. 16th, 1886.

Dear Captain Galton,—I regret that I am restrained by my doctor's advice from attendance at the meeting to hear your address. I would, if I might, have taken the opportunity of calling attention to the extraordinary depression of our agriculture, and to the fact that the only effectual means of retrieving it, in competition, will be by the use of the most efficient labour-saving machinery; and that our Society may conduce to that great object, by calling special attention to the past as well as the present inventions of machines which appear to have pretensions for the attainment of the object of cheapening the cost of agricultural production. I append an extract from some evidence which I have occasion to cite, which displays the general position of our agriculture in that respect. The continued and great increase of late of serious fires appear to render it expedient to recall attention to the investigations of our special committee on that subject, and to its conclusions which still remain for application, and to some important inventions which are stated to have been made since then for better security in the United States. The Commission on Elementary Teaching omits any reference to the physical training which the Society has hitherto promoted, successfully in part, for a thousand elementary schools. It appears to me that it is left to the special committee of our Society to maintain and advance in the public interests the grounds we have taken on that subject.

Yours truly,

Edwin Chadwick.

Captain Douglas Galton, C.B.,
Chairman of Council.

Appendix to letter, on the importance of Labour-Saving Machinery on Agriculture in the United States as compared with England :—

Mr. Albert D. Shaw, of the United States Consulate, Manchester, speaking of the agriculture in Lancashire, says :—"From a careful study of the cost of preparing the ground and putting in and harvesting crops in this country, I am fully satisfied that farm expenses are more than 100 per cent. dearer in many cases here than they are in America, notwithstanding the much higher wages paid with us. The fact is that the employment of labour-saving agricultural machinery is much more general and varied in our country than it is in this. In the matter of hay gathering, as an illustration in point, I recently saw a field of some ten acres in extent, the crop of which was being secured. The following was the *modus operandi* :—Two horses attached to a cart, 'tandem,' a boy to lead the horses, one man to pitch up the hay, two men to load with their hands, a boy to rake after, and there are three sets of workpeople after this fashion in this one field. Now, in America, with one man to load and drive his span of horses, and one man to 'pitch on' the hay, with a horse hay-fork to unload, more hay would be secured in one day than the three sets of workers were able to manage. The 'raking after' would have been done by a boy with a horse-rake after the field had been cleared of shocks of hay.

"This is not an overdrawn picture, but an important statement of an actual fact. What is true in the hay field applies with equal force to the harvest field. In passing by a field of wheat last season, I saw a reaping machine at work, and six men, two women, and three boys binding up the sheaves. In

the United States 'a reaper and self-binder,' with the help of two men, would do the same work equally as well, thus saving the wages of four men, two women, and three boys. These instances clearly show that English farmers are very unequally handicapped in the cost of handling crops alone. An English settler in the United States told me not long ago that he had learned to do twice as much work on his own land in one day as he used to accomplish in a day in England, and he added that 'he really believed he could go back to England and make money at farming,' as the result of his improved knowledge of how to expeditiously put in and gather crops at a great saving of manual labour, and consequently of expense."

The ATTORNEY-GENERAL (Sir Richard Webster), M.P., in proposing a vote of thanks to the Chairman, said he had listened to many inaugural addresses, and, without wishing to draw any comparison or say one word respecting the merit of any particular address, he thought he was justified in saying that, for the matter it contained, and for the information not ordinarily at the disposal of those attending these meetings, the address which they had just heard would be of the greatest use to the Society, and, when studied by those who read it, or thought over by those who had heard it delivered, would be of great practical utility. Captain Douglas Galton had called their attention to the improvements which had taken place in matters affecting health, particularly drainage, water supply, the supply of light, and the improvement of cities, notably of the metropolis, by the widening of streets. He felt sure such an address would be of practical advantage, as people would be able to see, by reference to such a short categorical statement, the various steps by which that progress had been achieved. Everyone who had studied the matter would agree that there was not, or should not be, any finality in matters such as these, and the knowledge acquired of what had been done in the past, ought to be an inducement and incentive to go forward and do better in the future. But that was not the only point of view from which the address was useful. Captain Douglas Galton had pointed out what had been done, not only in London, but in other cities, though he by no means suggested that the work had been done universally, and it must be apparent to all that there were many localities in which there was room for improvement, if only beneficent persons or those in charge of the places would do something to carry out improvements of the kind suggested. He thought they might be justly proud of the share which the Society of Arts had had in the improvements which had taken place, and first and foremost they must remember that all these things arose from the diffusion of knowledge. Without desiring to say one word more than he ought to in favour of the Society of Arts, or to depreciate what had been done by kindred societies, he thought they might fairly say that in the annals and records of that Society would be found stores of information which, from time to time, marked the fact that steps in progress had been elaborated, thought out, and produced by gentlemen who read papers in that room, and by men who had been distinguished members of the Society. In the diffusion of knowledge, and by the bringing it within the reach of those who could not attend the meetings, the Society had conferred a great benefit upon the population of these islands, and upon every English-speaking community. He was perfectly certain that the moral which Captain Douglas Galton intended to draw was, that if there was no finality in improvement and in what could be done, there certainly ought to be no finality in the efforts of the Society to do good. They were not simply to congratulate themselves upon what had been done in the past, but should use every effort to do still better and to produce still more beneficial results in the future. He could not help feeling that if those who were ignorant of these matters would read the address which had just been delivered, and then if they had any doubt as to whether such things still existed in some parts of London, which were not sufficiently visited by those who ought to have personal knowledge of these matters, that they would find ample opportunity for exertion and effort to mark, not only the jubilee year, but the succeeding years of her Majesty's reign, to ameliorate the condition of their poorer brethren. What the Society wanted was assistance in the work, and members should use their utmost endeavours to assist the poor, to encourage honest effort for self-improvement and self-teaching for technical education, and give a helping hand to those who were struggling to lift themselves from a lower station of life by cultivating the brains with which God had blessed them—nay more, those who had the advantages of being members of that Society, or had been blessed with better education or better means than others, should recognise that the highest privilege, as well as the first duty of wealth, position, and education, was to use their best endeavours to ameliorate the condition of their poorer brethren. The moral of the address to which they had listened was that they should go forward, and that moral was pointed by a review of what had been done in the past. He felt sure that much good would be done by this address, and, therefore, he had much pleasure in proposing a hearty vote of thanks to the Chairman.

Sir JOSEPH FAYRER, F.C.S.T., F.R.S., in seconding the motion, said he could well imagine that during the forthcoming year many stories would be told and accounts given of the achievements of the past fifty years, but he was certain that when her Majesty thought, as no doubt she would, of all the achievements in science and art, none would convey greater satisfaction to her than that which had been so eloquently recorded by the Chairman, though he had forgotten to mention the part which he himself had taken in sanitary progress.

Sir FREDERICK ABEL, C.B., F.R.S., supported the resolution. He thought that no better proof of the wisdom of the Council in selecting Captain Douglas Galton as its Chairman could be found than the interesting and useful address to which they had just listened. Captain Douglas Galton had for many years devoted his attention to the sanitary condition of the army, and from this point of view alone he had done eminent service to the country, in addition to which, in the various official positions he had occupied, he had distinguished himself as a champion of sanitary science. The subject touched upon that evening was of interest to every one, whether chemist or engineer, who desired to work together in this important subject. He had learnt a great deal from the address, and had no doubt that many present, from what they had heard, would combine together to advance sanitary knowledge.

Mr. J. H. MURCHISON, as one of the oldest members of the Society, begged to tender his thanks to the Chairman for the able address which he had delivered.

The motion having been carried by acclamation,

The CHAIRMAN briefly returned thanks for the same, and then proceeded to present the medals awarded by the Society to the following gentlemen:—

To PROF. FRANCIS ELGAR, LL.D., for his paper on "The Loadlines of Ships."

To HENRY DAVEY, for his paper on "Machinery in Mines."

To PROF. W. C. UNWIN, F.R.S., for his paper on "The Employment of Autographic Records in Testing Materials."

To C. V. BOYS, for his paper on "Calculating Machines."

To PROF. LEONARD WALDO, D.Sc., for his paper on "Watch-making by Machinery."

To JOHN MACKENZIE, for his paper on "Bechuana-land and Austral Africa."

To EDWARD COMBES, C.M.G., for his paper on "The Industries and Commerce of New South Wales."

To G. GORDON HAKE, for his paper on "Cyprus since the British Occupation."

To PROF. W. N. HARTLEY, F.R.S., for his paper on "Photography and the Spectroscope in their Application to Chemical Analysis."

To PROF. R. MELDOLA, F.R.S., for his paper on "The Scientific Development of the Coal-Tar Colour Industry."

To B. H. BADEN POWELL, C.I.E., for his paper on "Indian Manufactures from a Practical Point of View."

To CAPT. RICHARD CARNAC TEMPLE, for his paper on "Everyday Life of Indian Women."

Miscellaneous.

BOTANICAL GARDENS, NILGIRIS.

The following notes on some of the more interesting plants which have been introduced or grown in these gardens during the year 1885-86 are taken from the report of the Director, Government Botanical Gardens and Parks, Nílgiris, which has been received from the India Office :—

1. *Erythroxylon coca.*—This plant grows very rapidly from seed and cuttings, and a large number were raised in the greenhouses at Ootacamund. But the demand for it has ceased, and I think wisely, for although there can be no doubt but that the plant would grow well in many parts of Southern India, it would not be likely to compete profitably with the vast tracts of country in South America, where it is already so largely cultivated.

2. *Eucalyptus.* — Major A. C. Smith, R.E., Executive Engineer, Public Works Department, has frequently spoken and written to me about the desirability of growing the better sorts of Eucalyptus in this country for the purposes of timber. The following species flourish on these hills :—*E. marginatus*, *E. siderophloia*, *E. calophylla*, *E. piperita*, *E. obliqua*. All these are reckoned admirable as timber trees in Australia, and in the course of a few weeks I could supply the Conservator of Forests with seed of all of them.

3. *Castilloa elastica.*—Colonel Campbell-Walker, in a letter to the Board of Revenue, No. 2156, of the 27th January, 1886, embodied in G.O., No. 231, of the 24th March, 1886, Revenue, states that this valuable Indian rubber-producing tree has at last been finally established by Mr. T. J. Ferguson at Calicut. I saw Mr. Ferguson's trees 18 months ago, and they were growing magnificently, and as it has at last been found easy to raise these trees from cuttings, I hope they will in the future form no unimportant item in the forestry of this place. The other rubber-producing plants have so far been a failure, either through their not yielding as much rubber as they do in America, or because we have not yet learnt how to tap the trees properly.

4. *Mahogany.*—In my last year's report I stated that I had received two casks of the seed of this plant from Mr. Thiselton Dyer. The seed arrived in magnificent order, and was distributed chiefly to Colonel Campbell-Walker, and Mr. Gamble, of the Forest Department, and to the Agricultural Society in Madras. Almost every seed germinated, and tens of thousands of plants must have been raised. From a single pound sown in the green-houses at Ootacamund, between three and four thousand plants were obtained ; some of these have been sold, and the remainder will be handed over to Mr. Gamble.

I had the pleasure of visiting last autumn the teak forest in charge of Mr. G. Hadfield, Deputy-Conser-

vator of Forests, Nilambúr. It was a treat to see the grand growth which the teak trees had made during the last forty years. In the forest were many fine specimens of young mahogany trees, but they were suffering from the ravages of a grub which attacks the buds of all the leading shoots. In other situations the mahogany might not suffer from these pests.

5. *Quilaja saponaria.*—This plant thrives well in Ootacamund, and it is found that it can readily be propagated by means of cuttings, so that if it proves to be a tree of any value, it can be inereased to any extent.

6. *Kumera.*—The tubers of this plant have been raised, and on being eaten, proved palatable.

7. *Ullucus tuberosus.*—I have received this plant from Mr. Thiselton Dyer. It grows freely in the open air at Ootacamund, and it would seem likely to yield a heavy crop of small tubers. Its name is derived from the Ullucus, a river in the north-west of South America, in the neighbourhood of which it is found growing wild.

8. *Arracacia and the Cochin tuberous-rooted Vine.*—On neither of these am I able this year ro report, as the former has not produced any tubers, and the second, although it flowered at Barliyár for the first time this spring, has borne no fruit.

9. *Hop.*—I am indebted to Mr. J. L. Holland, the manager of the Nílgiri Brewery, for some cuttings of the hop, from which I purpose raising a large stock. I fear that the climate of these Hills is not likely to suit the plant, but I shall at any rate give it a fair trial.

10. *Ipecacuanha.*—In my last year's report I was obliged to confess that I had lost a large number of these plants, but during the past year, Mr. Jamieson, who has paid particular attention to again getting up our stock, has now about 200 plants. I saw a bed of Ipecacuanha growing very vigorously in the teak forest at Nilambúr, the climate of which seems to suit it much better than that of Barliyár.

11. *Pteroxylon utile.*—Mr. Gamble gave me a considerable amount of the seed of this valuable timber tree, which is a native of South Africa. On dissecting the seed it appeared to be perfectly sound, but on attempting to germinate it in the green-houses at Ootacamund, I failed completely, notwithstanding that it was sown under several different conditions. I am glad to hear from Mr. Gamble that he has been more successful, so that this tree will, I hope, be added to the long list of timbers which will in future years adorn our hills.

12. *Mr. J. Gammie, Superintendent of the Cinchona Plantations, Darjeeling.*—To this gentleman I am indebted for the seeds of several useful or ornamental plants growing in the neighbourhood of Darjeeling, the chief of which are *Phœnix rupicola, Areca gracilis, Wailichia disticha, Calamus flagellum, Hollbellia latifolia.*

13. *Miss Baker, of Peermaad, Travancore.*—To this lady the gardens are indebted for sundry *Impatiens* and *Souerilas*, collected on the mountains of Travancore. None of them has as yet flowered, but to judge from their leaves and their habit of growth, they appear to be different species to those which we get here, and as such will be of much interest.

14. *Mr. T. Hanbury.*—From the magnificent donation of seeds which we received from this gentleman through His Excellency the Governor last year, a very large number of plants have been raised in the green-houses. Among the most interesting of the plants are the acacias, many of which are new to the gardens, and bid fair to be very ornamental. *Fuchsia procumbens* also promise to make a fine basket plant.

15. *Coniferæ.*—Several of the Coniferæ grow magnificently on the Nílgiris. (1) *Pinus insignis.*—Trees of six years old are sixty feet in height, and those of fifteen years of age yield an abundance of excellent timber. (2) *Cupressus torulosa.*—Though not nearly so rapid in its growth as the former, this flourishes well, and at the end of twenty-five years makes a massive tree of sixty to seventy feet in height. (3.) *Cupressus macrocarpa* and its varieties grows with surprising rapidity, but from their branching character are more suited for the purposes as fuel than for timber. (4.) *Cryptomeria Japonica* grows well while young, and will, I have no doubt, grow into a fine tree, but there are none of any great age on the Nílgiris.

16. *Tristania conferta, Syncarpia, Caurifolia Angophora, subvelutina and Grevillea robusta.*—All grow rapidly and make fine trees. I was told that in the Wynaad there were *Grevilleas* which had been planted out only eighteen months, that were five and twenty feet in height. It ought, however, never to have been called *Grevillea robusta*, for it has in its living state the most brittle wood I know. The branches are always snapping off with the slightest breeze; but grown in sheltered places, it becomes a noble tree. Its wood is beautifully grained and is well adapted for all the purposes of the cabinet-maker.

SILK PRODUCTION IN PERSIA.

The silk-producing districts of Persia are Khorassan in the East, the provinces on the southern shores of the Caspian sea, and north of the Elborz range, named Gilan, Mazanderan, and Astrabad; the middle province of Persia, forming a district between Kashan-Yezd, and the north of Fars and Ispahan as a central point, and Azerbaijan in the extreme north-west. Consul-General Benjamin, of Teheran, states that in Gilan and Mazanderan nearly every family rears silk-worms, and much of the silk thus produced does not come into the market at all, being manufactured by the women of the family into coarse stuffs used for shirts, trousers, or handkerchiefs, while in the other district, where the silk produce is less important, every silk grower also retains a certain

quantity of silk for domestic use. The raw silk of Persia may be divided into three categories, the Abrishum, Guruk, and the Lâs. The first quality is divided into different numbers, according to fineness of texture, gloss, colour, &c. In Gilan and Mazanderan, the silk is collected at the end of May, and brought to market in the months of August and September; but in Khorassan and other districts of Persia the silkworms mature later, and the raw material is collected in June or July. Khorassan produces yearly about 16,250 pounds of raw silk. The centres of the Khorassan silk trade are Sabzvar and Nishapur, places lying under 36° north latitude, and from 3,000 to 4,000 feet above the level of the sea, on the northern confines of the lower salt deserts of Central Persia. The Khorassan silk is generally of very good quality, and is rolled in skeins of 30 to 31 inches in length. A small quantity of this silk is sent to Yezd and Kashan, some is brought by Russian traders, and exported from the port of Astrabad on the Caspian; but most of it is used for home manufacture in piece goods. A few years ago, the average annual production of Khorassan silk amounted to 40,000 pounds. The product of the Caspian provinces is generally divided into that of Gilan and Mazanderan, the latter including also the product of Astrabad; the Gilan silk is the best which Persia produces. The quantity produced last year amounted to about 7,000 bundles, of 65 pounds each. A bundle weighing 65 pounds at Resht, weighs, when it reaches Teheran, only 61·75 pounds. This loss of weight arises from the fact that, in the humid climate of Gilan, the silk is more or less damp, while it loses its moisture in the dry atmosphere of Teheran. The total product of raw silk which entered trade from Gilan, in 1882, was 432,250 pounds. It is rolled in skeins of 20 to 21 inches in length, and is sold at Resht, Lahija, Fumen, and other towns of Gilan, at the rate of 12 to 14 *tomans* per *shaman* of 13 pounds, the *toman* representing about 8s. The Gilan silk is occasionally mixed with Shirwân silk from the Caucasus, and then sent to Teheran. A large part of the silk of Gilan is manufactured at Resht, the provincial capital, into sewing-silk; and at other places of Persia, into trimmings, laces, fringes, cords, and similar stuffs. This is called *Alagbandi* silk. The sewing-silk, when ready for use, and dyed different colours, costs, at Resht, from 16 to 18 *kerans* per pound, the *keran* being equivalent to a little over 9d. Only the best silk, valued at 14 *tomans* per thirteen pounds, is used for this purpose, about 50 per cent. of the original price being thus added for cleaning, dyeing, twisting, &c. About 20,000 pounds of silk are annually converted into sewing silk.. The finest quality of Gilan silk is produced in the neighbourhood of Lahijan, particularly in several villages belonging to a certain Mirza Mohammed Ali Khan. The silk product of the adjoining province of Mazanderan amounts to about 35,000 pounds per annum. The silk is only of medium quality, rarely costing more than 10 *tomans* per 13 pounds. It is sold in bags weighing 78 or 65 pounds each. The centre of the Mazanderan silk trade is Barfurush. The silk products of the central districts of Persia amount to about 13,000 pounds per annum. This is the poorest in quality, and has never been exported, it being entirely used for home manufacture. The amount now produced is not likely to be increased, as the great scarcity of water existing in these districts interferes with the culture of the mulberry plantations. It is stated that the highest altitude at which silkworms thrive in Persia is 6,500 feet above the sea level. From statistical returns which have been prepared on the subject of the silk industry, it appears that the total amount of raw silk annually entering trade in Persia averages 608,000 pounds, with an aggregate value of £198,000, and the quantity exported during the year 1881-1882 amounted to 406,000 pounds.

AGRICULTURE IN DENMARK.

According to the latest returns, it appeared that in the year 1881 41 per cent. of the total area of Denmark was employed as pasture land, 33¼ per cent. as arable land, whilst 12½ per cent. consisted of moor land, 5½ per cent. of woods and forests, and 3 per cent. of fen land, the remainder being taken up by the hedges, roads, building grounds, tracts of quicksand, and inland waters. Consul Ryder, of Copenhagen, says that the grazing area is unquestionably that which occupies the most prominent position, taking the whole of the kingdom into account, for while the area of arable land may be found larger than that of pasture land in the islands, in Jutland, on the other hand, the latter has a greatly preponderating influence, inasmuch as it embraces 40 to 41 per cent. of the area of that part of the kingdom where the area under grain cultivation constitutes but 27 to 28 per cent. But while the area of moor land in the islands is only of limited extent, in Jutland it amounts to as much as 18 or 19 per cent. of the area. The forest area is much greater in the islands than in Jutland, the south-eastern part of Jutland having double the extent of forest land as compared with the remaining sections of that part of the kingdom. The inland sea area is also much larger in the islands than in Jutland, whilst the fen land is again much greater in Jutland, especially in the northern districts. Great divergence is to be noted in the different Jutland districts—for example, the south-western section having the smallest proportional area of grain and pasture land, with a very large area of moor land; and it is here, as well as in the northern part of Jutland, that the quicksand ranges are to be found, whilst the eastern division of Jutland appears to occupy a medium position as between the islands and the remainining Jutland districts. Taking the grain and pasture lands together, they are classed as follows:—Island of Fyen, with 86 per cent. of

total area; island of Falster, 85 per cent.; island of Zealand, 84 per cent.; island of Bornholm, 72·73 per cent.; South-East Jutland, 80 per cent.; Northern Jutland, 70 per cent.; South-West Jutland, 60 per cent. In respect to the grain-growing area, taking the whole kingdom into account, it appears that of the four main cereals, oats is that which is most extensively grown, the area under this crop being 32 per cent. of the total grain area. Next comes barley with 25 per cent.: then rye with 21 per cent.; and, lastly, wheat with 4½ per cent. Buckwheat is only cultivated to a very limited extent, chiefly in the south-eastern districts of Jutland; peas and beans principally in the island of Falster, and only to the extent of about 5 per cent. of the arable area. On the other hand, the cultivation of mixed seeds is proportionately large, namely, 7 to 8 per cent. for the whole of the kingdom, in the islands being as high as 12 to 13 per cent., whilst in Jutland it is only slightly over 4 per cent. As regards potatoes, the opposite appears to be the case, as these are most extensively grown in Jutland, and more especially in the less fertile districts. The other descriptions of roots are mostly cultivated in the islands, these consisting chiefly of mangolds, carrots, and sugar beets. In Jutland, where the area under roots is placed at 14,000 acres, are mostly grown turnips, carrots, and mangolds. Chicory is only to be found in the south-eastern district of Jutland. The area employed in the cultivation of commercial plants, such as flax, hops, and tobacco, is very small, scarcely amounting to more than 5,000 acres for the whole of the kingdom, 80 per cent. of these being devoted to flax. Of the pasture lands more than one-half of the area under them is employed for summer grazing, whilst the clover and grass hay fields contribute about 17 per cent. of the entire kingdom, and the hay from meadow lands about 16 per cent. The inland waters in the islands amount to 1 per cent. of the entire area, and, as regards woods and forests, these are much more extensive in the islands than in Jutland. Whilst beach constitutes the chief wood in the islands, pine is the most frequently met with in Jutland. The moor-land area is subdivided into the classes of peat and fen land, and a great difference is to be found here between the islands and Jutland. In the former, about three-fourths of the moor-land area is classed as peat, whereas, in the northern districts of Jutland only one-half of it is peat, the remainder being fen land; in the south-eastern and south-western districts, two-thirds of the moor area are placed under the class of peat-land. During the last twenty years a very large extent of moor-land has been brought under cultivation, and in the period comprised between the years 1876-1881, the area of cultivated land has been increased to the extent of nearly 100 square miles. This great advance has taken place more especially in the islands where the large proportion of 93 to 94 per cent. of the total area has been brought into use for agricultural purposes, and as wood and forests, whilst in Jutland only 72 to 73 per cent. has been so employed.

General Notes.

Potato Tercentenary Exhibition.—An Exhibition will be held at the St. Stephen's Hall, Westminster, from Wednesday, December 1st, to Saturday, December 4th; there will also be a conference on some of the unsettled questions connected with the potato. The Exhibition will consist of four sections:—1. A historic and scientific collection, to include early works in botany, in which the potato is figured; maps showing the European knowledge of the new world three hundred years ago, and the proximity of potato-growing districts to the ports most frequented; early books on travel and voyages in which references to the potato occur; works and papers in which attempts to define the different species are made; illustrations of the species and varieties; contemporary references to the voyages of Hawkins, Drake, Grenville, and Raleigh. 2. Illustrations of potato disease, and works on the subject. 3. Methods of storing and preserving potatoes; methods of using partly diseased potatoes; potato products of any kind. 4. A display of tubers of the various varieties grown.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 22...Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. Hastings Romilly, "The Islands of the New Britain Group."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Mr. Charles Ingrey, "The Ailsa Craig Fog Signalling Station."

Tuesday, Nov. 23...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on "Concrete as Applied in the Construction of Harbours."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Donald A. Cameron "The Tribes of the Eastern Soudan. 2. Mr. J. A. Olonba Payne, "West African Symbolic Messages." 3. Mr. T. R. Griffith, "The Races inhabiting Sierra Leone." 4. Rev. George Brown, "Papuans and Polynesians."

Wednesday, Nov. 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Anderson, "Filtration of Water by Agitation with Iron and by Sand Filtration."

Microscopical, King's College, W.C., 8 p.m. Conversazione.

Thursday, Nov. 25...Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Adjourned discussion on Mr. Gisbert Kapp's paper on "The Predetermination of the Characteristics of Dynamos." 2. Mr. James Swinburne, "Some Experiments on Secondary Cells."

Saturday, Nov. 27...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. G. Carey Foster, "Note on a Method of Measuring the Co-efficient of Mutual Induction of Two Coils." 2. Prof. A. W. Rücker, "The Stability of Liquid Surfaces."

Journal of the Society of Arts.

No. 1,775. Vol. XXXV.

FRIDAY, NOVEMBER 26, 1886.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 24, 1886; Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bailey, Thomas Jerram, Riga-villa, The Grove, Clapham-road, S.W.
Currie, John, Rowan Tree-bank, Alexandria, Scotland.
Dennis, Nelson F., 67, South-street, Southampton-street, Peckham, S.E.
Gresham, James, Craven Iron Works, Ordsall-lane, Manchester.
Rhodes, Henry Douglas, St. Stephen's Club, Westminster, S.W.
Smith, Michael Holroyd, Royal Insurance-buildings, Crossley-street, Halifax.
Turner, Eustace H., 43, St. Paul's-road, Highbury, N.
Wootton, Henry, Ambleside, Kew Gardens-road, Kew.
Zaehnsdorf, J. W., 36 Catherine-street, W.C.

The paper read was—

ON THE PURIFICATION OF WATER BY AGITATION WITH IRON AND BY SAND FILTRATION.

By W. Anderson, M.Inst.C.E.

The fact that iron possesses the property of removing from impure waters colouring matter and organic contamination has been known for these thirty years. In 1857, Dr. Medlock took out a patent, according to which water was to be purified by suspending iron in the tanks containing it; but no practical results followed till some eighteen years ago, when Professor G. Bischof took the matter up, and contrived the domestic filter, which now enjoys a deservedly high reputation. In these filters, the water, after a rough preliminary filtration, passes through a layer of iron in a coarsely granular condition, then through a stratum of native peroxide of manganese, and finally through a layer of filtering sand.

In applying iron to the purification of water upon a large scale, Professor Bischof adopts a different arrangement. The water first passes through a layer of ordinary filter sand, by which the mechanical impurities are separated, then through a layer composed of a mixture of three parts, by measure, of coarse gravel to one part of the granular iron, and, finally, the water is made to flow through an ordinary sand filter. In the layer of gravel and iron a chemical reaction takes place. The iron is slowly dissolved by the water through the combined agency of the free oxygen and carbonic acid which are always present, in variable quantities, in natural waters; the carbonate of iron and low hydrated oxides of the metal which are formed afterwards pass into a higher state of oxidation at the expense of the free oxygen in the water, or of that taken up from the air after the passage of the water through the iron and gravel mixture. I will not attempt to determine the precise nature of the purifying action, but the fact remains that iron is first dissolved in the water to the extent of about one-tenth of a grain to the gallon, and that, during this process and the subsequent deposition, a powerful effect is produced on organic matters held in solution.

Professor Bischof's system was for some time in operation on a large scale at the Antwerp Water Works, and left nothing to be desired so far as the cleansing effect on the water was concerned. But the River Nethe, from which the supply is taken, is a greatly polluted stream; the iron, therefore, had an abnormal amount of work to do, and in consequence the upper layers of the iron and gravel mixture got choked comparatively quickly with the dissolved impurities separated from the water.

It was curious to note the appearance of the iron filters. All that could be seen from above, when the water had been drawn off, was the ordinary surface of a sand filter, which had to be cleaned in the usual way about every fortnight. On digging through the sand no change could be detected till the spade arrived within a couple of inches of the iron mixture, when discolouration became apparent, and this con-

tinued to increase till the layer of iron was reached. For six or eight inches the gravel and iron particles were thickly coated and mixed with a reddish, slimy substance, the product of the chemical action of the iron. Deeper down the mixture was of an intense black, and had apparently remained unchanged during the four years that the filters had worked. The upper six inches of the iron mixture had to be removed and washed about every six months, but no difficulty was experienced from any concreting together of the mass. There is very little doubt but that, with purer water, the inconvenience and expense caused by the great deposition of slimy matter would have been less severely felt, and I believe that, in the case of domestic supplies and moderate-sized installations, Professor Bischof's system is the best yet introduced. The behaviour of the filters at Antwerp demonstrates conclusively that a true chemical action takes place, because the water, before it reached the iron, had undergone twelve hours subsidence and ordinary filtration through two feet deep of sand, and must, therefore, have been deprived of all the mechanical suspended impurities which sand was capable of taking from it; and yet the remaining impurities, when acted on by the iron, were sufficient to cause the clogging up of a very open mixture of gravel and iron, much too coarse to act as a filter, and which, as a matter of fact, permitted the water to issue on to the sand filters in the muddy condition which it must have acquired in passing through.

The rate of filtration was not nearly so rapid as was expected from preliminary experiments. It was thought that the water could be purified at the rate of 150 gallons per square foot per twenty-four hours. In reality, however, the rate did not exceed half that amount. For small installations and with fairly clean water it would be safe, I think, to make the iron and sand filters each have an area of such extent as to filter at the rate of eighty gallons per square foot per twenty-four hours.

The water, as it comes from the iron filters, should be allowed to fall in a shallow cascade or a balloon jet into the sand filter, so as to bring as large a surface as possible into contact with the air; with some kinds of water it is very difficult to remove a faint marshy taste and smell; in such cases, the blowing of a considerable volume of air through the water after treatment with iron, by means of perforated pipes, has been found beneficial, and the same method is efficacious in hastening the deposit of iron where there is not sufficient space to allow time for natural aeration. The depth over the sand should be such as to allow about four hours before the inflowing water reaches the sand. Thus, if the filtration be at the rate of 6 inches deep per hour, or $74\frac{1}{2}$ gallons per square foot per 24 hours, the water over the sand should not be less than 2 feet deep. Over the filters the water assumes a reddish hue, and a slimy deposit is left on the surface of the sand; this has to be removed from time to time in the usual manner, the frequency depending on the purity of the water to be treated, and generally also on the season of the year. When a filter begins to run sluggishly, its life may be increased by about 25 per cent. by trailing a light chain over the surface of the sand, and by that means breaking up the slimy deposit.

After four years' working, the demand for water by the city of Antwerp had increased to an extent which rendered it imperative that the means of purification should be extended. To double the existing arrangements would have involved the employment of 900 tons more iron and an extension of space which would have led to immense expenditure. Under these circumstances, I determined to try a suggestion first made to me by Sir Frederick Abel, of treating the water by agitation with iron instead of by filtration through it. Sir Frederick had pointed out that the action of the iron was of a chemical nature, and that it was desirable to present it continually to the water in the cleanest condition possible, and at the same time to cause the clean metal surfaces to come into contact with fresh quantities of the water under treatment; and that these conditions could be best secured by causing the iron particles to tumble about in a cylinder through which the water was caused to flow very slowly. The difficulty in the way of adopting Sir Frederick Abel's suggestion arose from the idea which prevailed, though not with him, that very prolonged contact, as much as three-quarters of an hour, between the water and the iron was indispensable; hence the scheme seemed almost impracticable for large volumes of water. Notwithstanding this prejudice, however, an experimental revolving cylinder was at last made, and it was very soon proved that even the impure waters of the Nethe could be perfectly dealt with by agitation with clean iron, with a contact of $3\frac{1}{2}$ minutes only. In working out this process I have been greatly indebted to Mr. G. H.

Ogston, who had been associated with me from the first, who had made all the analyses, and who had previously tested and condemned many other plans for attaining the object in view. The "revolver," as the purifying apparatus is called, consists of an iron cylinder arranged to revolve on its long axis on hollow trunnions secured to each end. The trunnions are fitted with pipes, connected to them by means of ordinary stuffing boxes and glands, so that the pipes remain stationary while the trunnions revolve water-tight round them. The trunnions are supported on ordinary pedestals, and a slow rotatory motion is given to the cylinder by means of a spur ring secured round one end, and driven by a pinion actuated by a suitable train of wheel work. The inlet pipe opens into the cylinder against a disc which forces the water to spread evenly in a radial direction, and the outlet pipe commences in the cylinder in the form of an inverted funnel, up which the water streams so slowly that none but the finest particles of iron are carried away. The inside of the revolver is fitted with curved shelves or ledges arranged in sets to hit and miss each other; these serve to scoop up the iron and shower it down again almost continuously through the water. One-tenth of the volume of the cylinder is filled with coarsely subdivided iron, either Professor Bischof's granular, so-called, spongy material, or iron cast into small bullets, or iron granulated by being poured into water, or by ordinary coarse cast-iron turnings or borings from engineer's shops. The last form of iron is found, so far, to be the most efficient. The motion of the cylinder is very slow. The Antwerp revolvers, which are 5 feet diameter and 15 feet long, with 10-inch inlet and outlet pipes, capable of purifying 500 gallons per minute, revolve once a minute, and require about 1-3rd horse-power to drive them.

In March, 1885, three of these revolvers were started at Antwerp, and the original iron and gravel beds were converted into ordinary sand filters; by this change the capacity of the works was at once doubled. The total weight of iron in use at one time was reduced from 900 tons to $3\frac{1}{2}$ tons, and all the expenses connected with digging over and washing the purifying materials were done away with.

When pure water is passed through a revolver, a certain amount of iron is dissolved, and then the water flows out a light grey colour. After two or three hours the colour changes to a reddish brown, and a deposit of rust takes place at the bottom of the vessel. If filtered at once, on escaping from the revolver, the liquid will generally be clear at first, but after a time it will sometimes get cloudy and the deposit of rust will take place, showing that the iron existed in the first instance in solution, and was afterwards precipitated by the action of atmospheric oxygen. If the water be impure, coloured, and charged with dissolved organic matter, it will issue from the revolver of a dark grey colour, and this will increase to an inky black in the case of very bad water, so that it is possible to judge of the quality of the water by the colour assumed during its treatment. If the impurities are not more than the iron can deal with, the liquid, on standing for some three or four hours, becomes lighter and lighter in colour, a black precipitate forms and sinks very slowly to the bottom, the colour becomes a dirty grey, and then the water will filter quite clear and bright. If the impurities overpower the iron, or are of a nature which the iron cannot effectually attack, a purplish colour remains, and the liquid will not filter colourless. As in the case of the Bischof filter, the time of repose and exposure to the air before filtration is obtained by providing a sufficient depth of water over the sand of the filter beds.

In addition to its chemical action, iron possesses the property of causing the very finely divided particles of matter, which cause opalescence and cloudiness, to coagulate to such an extent that they can be removed by filtration. The waters of the Nile, for example, which will not subside clear in any reasonable time, and which cannot be filtered bright by sand filters, yield a beautiful clear water if agitated with iron before filtration through sand.

From the nature of the case, the system described is absolutely permanent and constant in its action. The surfaces of the particles of iron are necessarily preserved bright and effective, and the slow waste being made good by periodic additions of fresh iron, the revolver, once set to work, will go on acting in the same manner for an indefinite time.

In a recent paper, read before the Institution of Civil Engineers, Dr. Percy Frankland * described certain results which he had obtained by agitation of water with various finely-divided solid substances, including the so-called spongy iron of Professor Bischof, and his results led him to the conclusion that the

* Proceedings of the Institution of Civil Engineers, Session 1885-6. Vol. 85.

simple process of agitation could accomplish "a most remarkable purification," but that its efficiency "cannot at present be relied upon, owing to the uncertainty of its success."

This conclusion may be correct with respect to such materials as chalk, charcoal, and coke, with which Dr. Frankland experimented, and which might have the effect of removing organised matter "by mere contact," to which he appears mainly to ascribe the results obtained by him, and the uncertain success of the treatment. But it is impossible to understand how the classification of finely-divided iron with these materials, "in regard to the dependence of its efficiency upon mere contact, and therefore, to the uncertainty of success of an agitating process in which finely-divided iron is the agent used," can be reconciled by the author with his statement of results obtained by him in the employment of iron as a filtering agent. Dr. Percy Frankland justly considered it of great interest to ascertain the character of the purifying results obtained by Clark's process upon the large scale. It is therefore to be regretted that he did not also examine into results which the treatment—by agitation of water with finely-divided iron—were furnishing upon a large scale, and thus eliminate the uncertain, and the consequently fallacious nature of the results of his small-scale laboratory experiments in this direction.

The effects of the treatment of water by iron may be classed under three heads:—

1. The invariable result is that the organic matter is altered in its chemical nature, and the albumenoid ammonia is reduced to from one-half to one-fifth of its original amount.

2. A reaction analogous to that in Clark's softening process appears in many cases to go on. The iron oxide which is produced by combining with some of the carbonic acid which holds the carbonates of lime and magnesia in solution in the water, causes some precipitation of these to take place, and hence an appreciable amount of softening generally results. Thus, at Antwerp, the boilers of the pumping station were originally fed with untreated water; a hard scale was consequently formed in them; but when the arrangements were altered, and the treated and filtered water was supplied, the scale was greatly reduced in quantity, and became of a very open friable character, which does not adhere to the boiler plates. In the same way, when water contains much iron in solution, the treatment with iron causes a deposition of the metal on account of the removal of the free carbonic acid, so that the waters of the Nethe have less iron in them after treatment than before. It is very remarkable how completely the iron is deposited from solution in this process; the merest trace only remains, an amount not greater than the Kent Company's water, for example, contains. An idea prevails that, because iron is used in purification, the water resulting must necessarily be unfit for many purposes, such as washing linen, paper-making, and so on. I have not been able to find any grounds for this prejudice. Fish live and thrive in the water; it is used exclusively by the famous Zoological Gardens at Antwerp; aquaria are supplied with it; and no complaints about its injurious effect on linen have ever been received.

3. Treatment with iron appears to destroy or remove much of the infusorial life. According to Dr. Frankland, Bischof, Voelcker, G. H. Ogston, and others, who have experimented in the laboratory, the treatment with iron prevents the development of that kind of microscopic life which is the cause of putrefaction of animal substances; and Mr. Ogston's experiments with sterilized infusions placed in sterilized chambers, and also with Dr. Koch's method, prove that the microbes causing fermentation and putrefaction are destroyed or removed.

At Antwerp, during the autumn of last year, the unusual drought, coupled with the great influx of visitors in consequence of the International Exhibition, made so severe a demand upon the purifying arrangements of the Water Company, that it proved impossible to remove entirely the marshy taste in the water. This caused considerable alarm, because the cholera was raging in Spain, and great fears were entertained lest it should travel eastward; the Town Council, therefore, appointed a Commission of five distinguished Belgian chemists to report on the condition of the water. The Commission made a very exhaustive examination, and reported that there was nothing deleterious in the water, that it was absolutely sterile to Koch's gelatine test, although life was developed by cultivation on potato slices. I do not venture to pronounce any opinion as to whether it is desirable or not to remove all infusorial life from water. There is no proof whatever, as yet, that it would be any advantage to do so, while there is evidence that microscopic life has the effect of naturally purifying water; and analogy would lead us to suspect that, just as small birds keep down insect pests, so some kinds of microbes, harm-

less in themselves, may be of great use in destroying dangerous germs.

It is well known that iron is inimical to vegetable and animal life. The presence of salts of iron in the soil produces sterility. Iron must not be used in the construction of aquaria, or of the pipes and pumps connected with them, for even creatures as hardy as eel fry show such strong repugnance to the water as it issues from the revolvers, that they make the most persevering efforts to crawl out of it, even up the vertical sides of the iron tank in which the water flows. It is not surprising, therefore, that it should prove inimical to microscopic life. It has been suggested that the presence of iron deprives the water of its free oxygen, and thus smothers animal life, and again it is thought that the slimy precipitate which is formed carries down and entangles the infusoria, and prevents them getting through the sand filters. However that may be, this property of iron is undoubtedly established, and would lead to the inference that, supposing dangerous as well as harmless germs to be destroyed, the worst water treated by iron is safer for dietetic purposes than the best natural supplies, because protection from contamination of water artificially purified is under the complete control of the establishment supplying it, for it can be kept in covered reservoirs and pipes beyond all risk of pollution; whereas, the best natural supplies, used in their natural condition, those from deep wells not excepted, are more or less open to contamination; witness the number of wells that have had to be abandoned in the outskirts of London, and the obvious ways in which springs and water-courses can be defiled.

The adoption of iron purification by water-works deriving their supplies from rivers liable to periodic muddiness and discoloration from floods, would obviate the necessity of having large intake reservoirs for the purpose of storing up water when the source is in a good condition, for use when it is too discoloured and polluted to be drawn upon. Not only would such a course save a vast amount of valuable space, but it would remove the danger which must accompany the exposure of a vast surface of water to the contaminating influence of the atmosphere of large towns, and who can tell how fatal this may be on the outbreak of epidemic disease? The practice adopted largely in London, for example, is to convert running streams into stagnant ponds situated in the midst of a dense population and surrounded by factories, and make such ponds the real source of supply.

The system which I have had the honour of bringing before you is now in operation on the large scale at Antwerp, at Gouda and Dordrecht, in Holland, and at the great ironworks of Messrs. Cail and Co., in Paris, where the waters of the Seine, considerably polluted by sewage and by the floating wash-houses, is taken from opposite the factory on the Quai Grenelle, and purified for the supply of the factory and the workmen's cottages. In addition, experimental apparatus of large size is in operation in Berlin, and at Ostende. In the case of the latter town, the object is to determine whether an abundant supply of good water, which the town stands much in need of, can be obtained at Jabbeke from a canal, the water in which, usually about the same quality as that of the Nethe, from which the Antwerp supply is derived, is subject to periodical pollution by the Espierre, a stream which drains a large manufacturing district. The apparatus has been at work since last spring, and has given very satisfactory results, the purified canal water being superior to any at present in use in the town.

A Table of analysis, showing the degree of purification attained is appended:—

Effect of Purification by Iron.

	Organic matter.		Ammonia.			
			Albu-menoid.		Free.	
	Before.	After.	Before.	After.	Before.	After.
Antwerp	77	31	·27	·08	·40	·00
Dordrecht	34	14	·14	·05	·12	·00
Gouda	151	85	·41	·23	·05	·03
Ostende (single purification)	135	76	·58	·22	1·30	·12
,, (double ,,)	—	40	—	·19	—	·23
Paris	51	25	·16	·06	·40	·00

The distinguished Antwerp chemist, Mr. Kemna, has found that in the case of bad waters, a double purification is possible, the water being twice passed through the revolver and twice sand filtered. The results, in the case of Ostende, are given in the Table. In his capacity as Consulting Chemist to the Antwerp Water-works, Mr. Kemna has devoted much time and research to the process, and to

him as well as Mr. Devonshire, the Resident Engineer, I am much indebted for many useful investigations and suggestions.

I will conclude this paper by exhibiting a laboratory apparatus, wherein the process which I have been describing is in actual operation.

The revolver before you is made of cast iron, and has a capacity of $1\frac{1}{2}$ litres. It is charged with one-tenth of its volume, or 150 c.c. of coarse cast iron borings, and is caused to revolve by means of a train of wheel-work driven through the agency of a band by a small electric motor, the power required being about $2\frac{1}{2}$ watts. The water to be purified is placed in the glass vessel, above the revolver, and is syphoned over into it through the hollow trunnions by means of a glass tube and india-rubber pipe, fitted with a pinch-cock. The water is delivered from the revolver into a series of four tall jars connected together by glass syphons, so arranged that the contents of one jar are drawn from its bottom into the top of the next in the series. This arrangement is adopted merely to avoid the inconvenience of a single jar four feet deep. The last jar delivers, by means of a syphon, into a sand filter, arranged in a large glass beaker, the filtered water being syphoned over into a Winchester quart bottle. Beside this filter is a second one, in which, by way of contrast, the water being purified is filtered direct without the intervention of the iron treatment.

The fluid being operated on consists of Kent Company's water, contaminated by the addition of 4 per cent. of a strong infusion of leather cuttings, which give it a strong yellow colour, and the like amount of house sewage of a very pronounced odour.

The apparatus was started three hours before this meeting commenced, and was stopped as soon as the glass jars were full, in order to give the time necessary for the chemical action to take place, and restarted when the meeting commenced. You will, probably, be able to notice the difference in shade of each succeeding jar, the black deposit at the bottom of each, and the same on the surface of the sand in the filter. The dirty yellow water you see has been changed into a colourless fluid, while the same water, merely filtered through sand, retains nearly all its colour, though it has become somewhat clearer.

I place into beakers a sample of the water supplied by the water company to this house, a sample of the water you have seen purified, and another of the same water unpurified, but filtered through sand only. I add to each beaker an equal quantity of a weak solution of permanganate of potash, and you will see, in a few moments, that the purified water does not yield much in colour to the water company's supply, while the original water has hardly changed colour at all, the permanganate having been reduced by the impurities.

The cost of applying this method of purification depends, of course, upon local circumstances, and the quality of the water to be treated; but the capital outlay, where filters exist already, may be taken as £1,000 per million gallons per 24 hours, while the working expenses are merely nominal, the revolvers running without any attention beyond regular oiling, and the addition, once a week, of a fresh supply of iron. The cost of the water at Antwerp, delievered into the town main under a pressure of 280 feet, does not exceed three-quarters of a penny per thousand gallons in working expenses of all kinds. Where filter beds exist, as at Dordrecht, and Gouda, in Holland, the revolving purifiers can be added without any substantial alteration, and the filter beds can generally be worked at a greater rate than when the untreated water is to be made reasonably fit for use.*

DISCUSSION.

Mr. T. E. DEVONSHIRE said he had had, as resident engineer of the Antwerp Water Works, special opportunities of following the experiments of Mr. Bischof and also of Mr. Anderson. The difficulties experienced with the former process were purely of a mechanical kind, and it was given up with great regret, but it was found necessary to adopt some more simple method for supplying the increased demand for water. It was first thought that the obstruction of the filter took place in the layer of sand which was above the mixture of iron and gravel, but on removing and washing this, only a slight improvement was effected; then an obstruction was found in the interstices of the brick bottom on which the spongy iron mixture lay, and on that being removed, things went better for a time. Then they tried breaking up the surface, or upper crust, of the layer of spongy iron, thinking the obstruction was caused by its rusting up, this was not the only cause; there was also a chemical action of the iron on the water,

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* Further information may be obtained by reference to the "Proceedings of the Institution of Civil Engineers," vol. lxxii. p. 24, vol. lxxxi. p. 279 and p. 287; "Journal of the Royal Agricultural Society," vol. xx., part II., 1884, p. 631. "Rapport sur la qualité de l'eau de la ville d'Anvers pendant l'été de 1885." In the library of Institution of Civil Engineers.

which was found to filter through the upper sand quite clear, and then to become affected by the iron, and after some months' search, a sort of paste, largely composed of silica and alumina, and very impervious to water, was discovered; it was entangled in the more or less firm mass of oxidised iron at the surface of the mixture. He estimated that the extra expense caused by breaking up this surface would be £200 a year, which would be twice the amount of the interest on the installation of Mr. Anderson's purifiers, sufficient to give twice the quantity of water. It was also found that breaking up the surface with a fork spoiled the mixture, as the iron gradually settled down, leaving the gravel at the top. The purifiers were adopted at the beginning of last year, and were at work in March, but were not quite successful at first. From observations of the river during the three previous years, it was calculated that three-and-a-half minutes' contact would be sufficient; but owing to an unusual drought the river became much worse than usual, being much contaminated from the sewers of Brussels, which came up with the tide, so that they had to allow five minutes. At the same time, consumption was greatly increased, not only on occasion of the drought, but also of the Exhibition, the result being that they had not enough purifiers; and imperfectly purified water went to the consumers, which led to several complaints, and the appointment of a committee of inquiry. The committee began their labours in a thoroughly sceptical spirit, thinking that this process was simply a means of decolorising the water and removing the clayey matters, but in the result they entirely confirmed the concl o- the English chemists and engineers, the only recommendation being that the Company should increase the apparatus, which had already been decided on. Two new purifiers had now been added, and means provided for the more effectual aëration of the water before it reached the sand filters. At times, in the height of summer, when the water was very bad, there was a strong taste which could only be removed by energetic aëration. Mr. Anderson had referred to the necessity of having a certain depth of of water over the filters, to provide for aëration and the precipitation of the various oxides and carbonates of iron, by their conversion into ferric oxide. At Antwerp this was so, because the day's supply had to be taken into subsiding reservoirs in a space of some forty minutes time during the falling tide, but in works where water could be taken in at all times of the day, a great economy could be effected by purifying the water at the intake, before receiving it into the subsiding reservoirs. A subsidence oi from four to twelve hours would thus be possible, which would suffice for the deposition of all the clayey matter and for the greater part of the insoluble ferric oxide. The surface water could then be decanted off and passed through filters, which might be shallower than at present, and a high speed of filtration allowed. In laboratory experiments he had frequently filtered at the rate of 200 to 220 gallons per square foot per twenty-four hours, but on a large scale so high a rate would not be economical, because the ferric oxide remaining in the water would be drawn down mechanically too deep into the sand; a rate of 100 gallons per square foot for twenty-four hours, however, might safely be permitted. He had lately, in conjunction with Professor Kemna, experimented on a large number of waters. About 100 analyses had been made of Antwerp water, a dozen of Ostend, and three or four of Paris. They had been trying to arrive at a theory of the action of iron, and by comparing various results they had come to the general conclusion that it was primarily the dissolved carbonic acid which acted, forming carbonates of iron which were changed immediately into ferrous oxide, and subsequently by atmospheric oxidation into insoluble ferric oxide. In the case of Mr. Bischof's process, the reduction in point of hardness was about 30 per cent., but with the purifiers it was very small, but that might be explained by the difference in the time of contact. The carbonic acid dissolved in the water would be the first to act on the metallic powder and produce carbonates, but if a longer time were given, the iron would be capable of dissociating the bicarbonate of lime, and taking up a portion of the carbonic acid to produce carbonate of iron, which would be changed at once into ferrous oxide, and the carbonate of lime would be precipitated. All the experiments made this summer at Ostend were with ten minutes' contact. About a month ago they had an opportunity, during a rainy period, of allowing the same time at Antwerp, but the analysis showed not the slightest chemical improvement; but there was this inconvenience, that owing to the large quantity of ferrou s oxide produced, the aëration required to be much increased to convert it into ferric oxide, and this not being done, they had constant complaints from the turncocks that they could not keep the dead ends of the mains clean. Profiting by this experience, he had increased the speed of purification in the Ostend experiment, and the analysis showed that there was a marked improvement in the water on reducing the contact from ten to five minutes. This was mainly in the organic matter, and he held it was owing to the method in which this was estimated, viz., by the permanganate of potash test, the comparatively high figures given in the Table on the wall being due in part to salts of iron left in the water by insufficient aeration after long contact, salts of iron readily reducing the permanganate. He had received an analysis from Ostend this last week showing the organic matter reduced from ·94 to ·36, as against ·135 and ·76, and the free ammonia was reduced from ·86 to ·4, the albumenoid ammonia from ·32 to ·12½. It was found on the large scale that free ammonia was entirely removed, but in laboratory experiments it frequently increased, but this arose from its absorbing ammonia from the air of the laboratory. The Belgian Commission found that the taste complained of during July and August,

1885, accompanied insufficient purification, but also that it persisted for a certain time after the chemical purification was satisfactory. Their explanation was that the action of carbonic acid on cast iron containing carbon was to produce hydrocarbons, which were the cause of this taste. To prove this, they produced the same effect by agitating an ordinary "syphon" of aërated water with metallic iron. They had looked up the literature of the subject, and found that Cloëz and several other chemists had arrived at results to some extent confirmatory this view. The cost of the process at Antwerp, for an average daily supply of 1,650,000 gallons, apart from interest on capital, was 18s. per million gallons, including sand filtration. The purification added to filtration hardly cost anything at all, and he must say that, in most cases, purification and filtration together would cost less than filtration alone, especially where purification was used mainly for decolorising. The Dutch waters were highly charged with peaty matter, and the best mechanical filtration would not remove the colour, but contact with iron did so immediately. To obtain saleable water, the rate of 45 gallons per square foot per 24 hours could not be exceeded with ordinaay sand filtration, whereas if preceded by iron purification, twice this rate may be attained, and the delivery of the same area of filters thereby doubled.

Prof. BISCHOF was very much gratified to find so much agreement between Mr. Anderson and himself, but there were one or two points on which further information would be desirable. Without wishing to base any claim upon it, he might say that a revolver had been before his mind for twenty years, and that eighteen years ago he took out a patent for one in connection with spongy iron, and he had only hesitated to apply it to the purification of water from the fear, which was not even now quite removed, that it would be impossible to absolutely secure that every particle of the water should come in contact with the purifying medium. It would not do, however, to purify one half of the water thoroughly, and mix that with the other half which was not purified at all. What experience he had had with the revolver was unfavourable, but he did not attach much importance to that, as he understood that it was not at the time in proper order. Reference had been made to the Report of the Municipal Commission at Antwerp, in which the conclusion was stated that the revolver was an improvement on the previous method, not from a biological but from a chemical point of view, to prove which reference was made to analyses in paragraph 11 of the report. In that paragraph there were several analyses of water by Dr. Frankland, before and after filtration through spongy iron, in which the organic matter, as shown by the organic nitrogen and carbon present, was reduced 65·5 per cent., and then there was a statement that frequent tests had been made of the Antwerp water before and after filtration, with at least as satisfactory a result by a member of the Commission; on the following page there were the analyses made by the Commission after treatment of the water in the revolver, where the reduction in organic matter was stated to be 35 per cent. He did not see how this result justified the statement that the revolver was an improvement on filtration from a chemical point of view. Of course he did not mean to imply that these were the only results which could be obtained in the revolver, but they were the only ones printed in the report on which a comparison could be founded. He (Mr. Bischof) had made similar experiments to those of Dr. Percy Frankland bearing directly on iron, which he communicated to the Society of Chemical Industry at the beginning of the year. He found that spongy iron was eleven times more efficient at starting in removing organisms than iron filings, and after six weeks it was forty times more efficient, but iron filings were infinitely more efficient than animal charcoal. One point in connection with this apparatus was the facility with which the quantity of water passing through the revolver might be increased, which might prove dangerous, and he would suggest that some simple, self-acting apparatus might be devised which would register the flow of water, so that the resident engineer might always have the means of seeing that the apparatus was being worked properly. There must always be a great difficulty in filtering the water of a small tidal stream, little better than an open sewer, through a necesarily close filter, but he believed even now, that if the notion of the revolver had not taken hold of Mr. Anderson, filtration would have been found practicable. He would remind him of a report in which he stated that the sluices for flushing the spongy iron filters were inadequate, and it was quite possible that less difficulty would have been experienced if those sluices had been of proper size. At any rate, he was glad to hear that the results of filtration had always been satisfactory, as to which he might also quote a statement by the chairman of the Antwerp Water Works Company, after the filters had been in use nearly three years. He said:—"With respect to filtering by spongy iron, which has been a matter of doubt amongst scientists, this company has proved the complete success of that process." Nevertheless, if it could be proved that this apparatus did what Mr. Anderson said it could do, the revolver would have his hearty support. Filtration, however, was being tested at the present moment in a city of at least equal importance to Antwerp, and within the last few days he had heard that there was a probability of its being applied in a town not far from London.

Mr. G. H. OGSTON said he could confirm what had been stated by Mr. Anderson and Mr. Devonshire. He had passed numerous samples of water through a revolver similar to the one on the table, with the invariable result of removing the colour, but with a very variable result on the ammonia, both albumenoid and free. The sterilising effect of the process on the

water was to him a proof that every part of it came in contact with the iron, for if only half had been purified, the remainder would have been quite sufficient to set up putrefactive changes in a meal solution. He thought also it could be demonstrated mechanically, that it was only a question of time, and the necessary time could be calculated.

Mr. W. SMARTT thought there would be a possibility of the water which had passed through this apparatus not being perfectly pure, although it might be perfect in appearance and unobjectionable in taste. Fish would live, and watercress would grow, in very impure water, and even if *infusoria* were killed, the germs might remain. Therefore, though this process might be very admirable for improving an inferior water, it would be far better to obtain the water pure in the first instance. He was the inventor and patentee of a process for doing this by intercepting the water in the strata between the original source and the rivers, which could be adopted before using this purifying process.

Dr. ANGELL (Southampton) said he had recently had an opportunity of making an independent observation at Antwerp, and he considered the revolver perfect as a mechanical appliance. The chemical action of iron was not due to actual contact, and it was not necessary that every particle of water should come in contact with the iron; a certain amount of iron went into solution, which would mix with the remainder. As a chemist, he considered the effect of this process was entirely opposite to that of spongy iron, the latter being very largely one of oxidation due to the porosity of the material, whereas in the former case it was a process of reduction, the purification taking place to a large extent by the peculiar compounds which were formed between the precipitated iron and the nitrogen of the nitrogenous matter. That was the only way in which he could account for the difference of results between this process and the natural one of oxidation. This process actually removed the nitrogen, but the water, even in the deepest wells, was often largely charged with nitric acid. These peculiar organo-metallic compounds formed large flocculi, such as he had noticed in streams which issued from cemeteries, where the soil was ferruginous. He had collected this, and found a considerable amount of nitrogen in it. He understood that Professor Bischof considered his a reduction process, but if so, the porosity could have nothing to do with it, and he did no see how a bed which yielded up iron in solution could be the final proof of a process for purifying water for drinking purposes. He believed the value of Professor Bischof's system lay in the large surface presented by the extreme porosity of the material, and if he could increase the porosity without stumbling on the difficulty of oxidation, he would have the most valuable material which could be conceived for filtration. Such a substance was spongy platinum, and if anything similar and cheap enough for the purpose could be discovered, it would be perfection of a filtering material.

The CHAIRMAN, in proposing a vote of thanks to Mr. Anderson, said he had an opportunity two years ago of seeing this process in operation, and it certainly seemed to fulfil all that had been said of it. This was a most important question, because if such water as that of the River Nethe could be made fit for drinking, it was evident that the same process would be applicable to the purification of the sewage of towns, and they might expect very important results from it in future. He did not know if the Metropolitan Board undertook the water supply of London, whether they would be able, by adopting this method, to purify the sewage, and give it back as drinking water, but it was evident that such a thing was within the bounds of possibility.

The resolution having been carried unanimously,

Mr. ANDERSON, in reply, said Mr. Ogston had already given the answer to Mr. Bischof's question, about the possibility of a portion of the water escaping purification. The perfect manner in which it was proved to be sterilised showed that no such escape took place. With regard to the regulation of the supply to the revolvers, it was effected by screw pumps, which delivered a certain quantity at each revolution, so that the quantity passed through the apparatus depended on the rate at which they worked. The engineer in charge knew by the state of the river, and the season, what length of contact to allow, and regulated the pumps accordingly. He could not answer the question raised by Mr. Bischof, whether his system of filtration was practicable on a large scale with very impure water; he, with Mr. Bischof, struggled to make it so at Antwerp for a long time and did not succeed, and for aught he knew, they might have been experimenting up to the present time if a new method had not been adopted. Still he had so much respect for Mr. Bischof's ability and energy, that he had great hopes he might yet find some means of solving the problem. With regard to the purification of sewage, and rendering it fit for drinking, though the Chairman no doubt spoke in jest, he might say that two years ago Mr. Ogston and himself succeeded in producing from the effluent of the Hertford sewage a liquid which was perfectly drinkable; not only chemically satisfactory, but agreeable to the taste; although he should not advocate such a thing so long as other water could be obtained. It was quite certain, however, that sewage water could be returned to the rivers chemically as pure as the rivers themselves.

Obituary.

FREDERICK PITMAN.—Mr. Pitman, who has been examiner in shorthand for the Society of Arts from the foundation of the examination in that subject in

1376 until the present time, died at his home at Crouch-end, on Sunday, 21st inst. He was elected a member of the Society in 1861.

JOSEPH ZAEHNSDORF.—Mr. Zaehnsdorf, the well-known bookbinder, who had been a member of the Society of Arts since 1862, died at his house in London, on the 7th inst., in the 73rd year of his age. He was born at Pesth, in Hungary, on the 28th February, 1814, and after serving his travelling apprenticeship at Vienna and Paris, he came to London about the year 1837. He entered the house of Mr. Mackenzie, one of the best known binders of his day, and remained there until about 1840, when he set up in business for himself in the immediate neighbourhood of the present workshop of the firm in Catherine-street, Strand. Mr. Zaehnsdorf exhibited at the London International Exhibition of 1862, where he received honorable mention. At the Annual Exhibition of 1874, at South Kensington, he exhibited, and opened a special workshop, so that the visitors might inspect the processes of bookbinding. He obtained medals at the Anglo-French Working Class Exhibition, held at the Crystal Palace, in 1865; at the Dublin Exhibition of 1865; at Paris, in 1867; at Vienna, in 1873; and at South Kensington, in 1874.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

DECEMBER 1.—Adjourned Discussion on the paper read by DR. C. MEYMOTT TIDY, on "Sewage Disposal." (Read April 14, 1886.) SIR FREDERICK ABEL, D.C.L., will preside.

DECEMBER 8.—"Glow Lamps, their Use and Manufacture." By MAJOR-GENERAL C. E. WEBBER, R.E., C.B.

DECEMBER 15.—"Cameo Cutting as an Occupation." By J. B. MARSH.

At the meetings after Christmas the following papers (among others) will be read:—

"Miners' Safety Lamps." By EDWARD H. LIVEING.

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Photographic Lenses." By J. TRAILL TAYLOR.

"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Irish Industries." By REV. CANON BAGOT.

"Adulteration of Beer." By A. GORDON SALAMON.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

"Railway Brakes." By WILLIAM P. MARSHALL.

"Electric Locomotion." By A. RECKENZAUN.

"The Living Organisms of the Air: the Effect of Place and Climate on their prevalence."

CANTOR LECTURES.

The First Course will be on "Principles and Practice of Ornamental Design." By LEWIS FOREMAN DAY. Four Lectures.

LECTURE I.—NOVEMBER 29.—*The Anatomy of Pattern.*—The origin of pattern. Its construction. The dissection of pattern design. The skeleton. Its modification by the conditions of manufacture and commerce. Practical hints on pattern planning.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOV. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "The Principle and Practice of Ornamental Design." (Lecture I.)

TUESDAY, NOV. 30...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Renewed Discussion on "Concrete as Applied in the Construction of Harbours."

WEDNESDAY, DEC. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on the Paper by Dr. C. Meymott Tidy on "Sewage Disposal."

Geological, Burlington-house, 8 p.m. Mr. Frank Rutley, "The Metamorphic Rocks of the Malvern Hills." 2. Prof. P. Martin Duncan, "A new Genus of Madreporaria—*Glyphastræa*, with remarks on the *Glyphastræa Forbesi*, Edw. & H., sp., from the Tertiaries of Maryland, U.S." 3. Mr. Arthur Wm. Waters, "Fossil Chilostomatous Bryozoa from New Zealand."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Opening Address by the President, Mr. E. H. G. Brewster.

THURSDAY, DEC. 2...Antiquaries, Burlington-house, W, 8 p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Francis Day, "The Lochleven Trout." 2. Dr. H. Trimen, "Hermann's *Ceylons Herbarium* and Linnaeus's *Flora Zeylanica.*" 3. Henry W. Bates, "New Species of *Brachyonychus* from Mergui."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. M. M. P. Muir, "Bismuthates." 2. Dr. James Blake, "The Action of Inorganic Compounds on Living Matter." 3. Mr. T. E. Thorpe and Mr. A. J. Greenal, "Morindin and Morindon."

FRIDAY, DEC. 3...Civil Engineers, 25, Great George street, S.W., 7½ p.m. (Students' Meeting.) Mr. Harley H. Dalrymple-Hay, "Ranging Circular Curves."

Geologists' Association, University College, W.C., 8 p.m. 1. Mr. A. Smith Woodward, "Fossil Leathery Turtles and their Occurrence in British Eocene Deposits." 2. Dr. Henry Hicks, "Some Further Researches in Bone Caves in Wales."

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FRIDAY, DECEMBER 3, 1886.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

SECTION OF APPLIED ART.

The Council have decided to form a Section of Applied Art. Six meetings will be held during the Session, at which papers on the application of art to industry will be read.

The following is a list of the members of the Committee of this Section:—Captain Douglas Galton, C.B., LL.D., F.R.S. (Chairman of the Council), R. Brudenell Carter, F.R.C.S., Lord Alfred S. Churchill, B. Francis Cobb, Colonel J. F. D. Donnelly, R.E., C.B., Henry Doulton, Sir Villiers Lister, K.C.M.G., Members of the Council; T. Armstrong, R. W. Binns, F.S.A., Sir George Birdwood, M.D., C.S.I., Prof. A. H. Church, F.C.S., Walter Crane, Lewis F. Day, J. Hunter Donaldson, Robert W. Edis, F.S.A., George Godwin, F.R.S., Ernest Hart, Hubert Herkomer, A.R.A., T. Buxton Morrish, J. Hungerford Pollen, E. J. Poynter, R.A., E. C. Robins, F.S.A., William Simpson, J. Sparkes, R. Phené Spiers, F.S.A.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

NEW MEMBERS OF COUNCIL.

The Council acting under the 84th Byelaw, by which provision is made for filling up vacancies occurring in the Council, have elected Sir Juland Danvers, K.C.S.I., and Major-General Sir Charles Warren, G.C.M.G., as members of Council in place of Dr. R. J. Mann, F.R.C.S., deceased, and Mr. W. G. Pedder, C.S.I., resigned.

CANTOR LECTURES.

Mr. Lewis F. Day delivered the first lecture of his course on the "Principles and Practice of Ornamental Design," on Monday evening, 29th November. The special subject of the lecture was the Anatomy of Pattern, in which the lecturer traced the origin of pattern, and explained, by means of a series of designs on the wall, the dissection of pattern showing the original skeleton and its modification by the conditions of manufacture and commerce.

The Lectures will be printed in the *Journal* during the Christmas recess.

Proceedings of the Society.

THIRD ORDINARY MEETING

Wednesday, December 1, 1886; Sir Frederick Abel, C.B., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Berry, Henry Percival, 3, St. James's-street, S.W., and 14, Westbourne-villas, West Brighton, Sussex.
Bowring, Algeron C., 30, Eaton-place, S.W.
Buck, Sir Edward C., Calcutta.
Courtney, Frank Stuart, Palace Chambers, 9 Bridget street, Westminster, S.W.
Horrocks, Joseph, 10, Union-street, Southport.
Reynolds, Edwin A., Holborn Sanitary Engineering Works, 82, Belvedere-road, Lambeth, S.E.
Seward, Edwin, St. John's-chambers, Cardiff.

The following candidates were balloted for and duly elected members of the Society.

Abel, Charles Denton, 11, East Coombe-villas, Blackheath, S.E.
Baxter, Charles Edward, 24, Ryder-street, S.W.
Beall, George, 21, Fountayne-road, Stoke Newington, N.

Bennett, Lieutenant-Colonel William, Yorkshire Regiment, Assouan, Upper Egypt.
Bird, William Macdonald, 5, Gloucester-crescent, Hyde-park, W.
Bonn, John Edwin James, Brading, Isle of Wight.
Bradshaw, William, M.D., 122, Holland-road, W.
Bucknall, Edward, 78, Junction-road, Highgate, N.
Burr, Ebenezer Bantor, 85, Gracechurch street, E.C.
Cargill, William Walter, Lancaster-lodge, Campden-house-road, W.
Charubin, Gustavus A., 8, Finch-lane, E.C.
Clyne, Arthur, 6, Golden-square, Aberdeen.
Cole, Major-General Robert, Woolmer-lodge, Burgh-heath, Banstead.
Cousins, Edward, Palace-chambers, Westminster, S.W.
Cowie, George, 93, Philbeach-gardens, Earl's-court, S.W.
Cruttenden, Henry Edward, Brittany-house, London-road, St. Leonards-on-Sea.
Dangar, Frederick Holkham, Lyndhurst, Castle-hill, Ealing, W.
De Colyar, Henry Anselm, 24, Palace-gardens-terrace, W.
De Lissa, Samuel, 64, Onslow-gardens, S.W.
Densham, George W., 45, Cochrane-street, St. John's-wood, N.W.
D'Monte, Dominic A., M.D., Bandora, Bombay.
Douglas, Thomas, Greenwood, Frant, Tunbridge Wells.
Ebbs, Alfred, 2, Southampton-street, Bloomsbury, W.C.
Edwards, Walter Cleeve, Engineer in Chief's-office, Wellington-Manawatu Railway Company, Wellington, New Zealand.
Flint, John Henry, Oaklands, Grove-park, Lee, S E.
Fox, William, Leeds Forge Company, Limited, Leeds.
Game, James Aylward, Westwood-lodge, Sydenham, S.E., and Yeeda-grange, Trent, New Barnet, Herts.
Gauntlett, William Henry, Middlesbrough-on-Tees.
Gibbins, Richard Cadbury, Berkley-street, Birmingham.
Gilbert, John J., 72, Cambridge-street, The Crescent, Birmingham.
Goulty, Wallis Rivers, Albert-chambers, Albert-square, Manchester.
Grant, John Macdonald, Queensland Government-office, 1, Westminster-chambers, S.W.
Greswell, William Henry Parr, M.A., Stowey-court, Bridgwater, Somerset.
Gulland, James Ker, 6A, Victoria-street, S.W.
Harrison, Charles, M.D., 30, Newland, Lincoln.
Harrold, Leonard Frederick, Wanstead-hall, Snaresbrook, Essex.
Haskins, John Ferguson, 114A, Queen Victoria-street, E.C.
Hawthorn, James Kenyon, Glenholme, Leigham-court-road, Streatham-hill, S.W., and 5, Lime-street-square, E.C.
Hoffnung, S., 3, Hyde-park-gate, S.W.
Ison, Edward, Mountfield, Ashby-de-la-Zouch.
Jackson, Arthur C., Hardwick, Vermont, United States, America.
Jennings, John Rogers, Minster Lea, Reigate, Surrey.
Keays, Arthur Maitland, 11, Burch-road, Rosherville.
Kinninmont, A. T., 26, Chilworth-street, W.
Kirkcaldie, Robert, Villa Rosa, Potter's Bar, Middlesex, and 27, Milton-street, E.C.
Knowles, Charles, St. Cuthbert's, Marlborough-road, Putney, S.W.
Lascelles, John, 13, Percy-road, Shepherd's-bush, W.
Lawe, Captain Patrick Molle, Junior Army and Navy Club, S.W., and Constitutional Club, S.W.
Lawrie, Alexander, Raggles-wood, Chislehurst, Kent.
Lay, Edward Warren, The Limes, North-end, Hampstead, N.W.
Lehmaier, George, 11, Queen Victoria-street, E.C.
Lovett, Henry Albert James, B.A., 1, Guildhall-chambers, Basinghall-street, E.C.
McIntyre, J.P., 3 and 4, New Basinghall-street, E.C.
Mackay, Robert Fenton, 3, Rose Angle, Dundee.
Manbré, Alexander, 21, Blackstock-street, Liverpool.
Marshall, Arthur, Third Avenue, Sherwood-rise, Nottingham.
Marshall, Sir James, C.M.G., Richmond-house, Roehampton, S.W.
Mash, John William, 48, Tollington-park, N.
Mason, Hugh Herbert, M.R.C.S., Abbey-lodge, Barking, Essex.
Mews, John, J.P., 103, Westbourne-terrace, W., and Hartwell-house, Hartfield, Tunbridge Wells, Kent.
Moodie, George Pigot, 1, Sussex-place, Hyde-park-gardens, W.
Mooney, Joseph J., Tib-street, Manchester.
Moore, Arthur Chisholm, 23, Essex-street, Strand, W.C., and The Lodge, Boreham, Chelmsford.
Mullens, John Ashley, Broom-hall, Teddington.
Nanson, Tom, 9, Park-crescent, Stockwell-park-road, S.W.
Niven, George, Erkingholme, Coolhurst-road, N.
Peake, George Herbert, B.A., LL.B., 1, St. James's-street, S.W.
Perry, William, Hanbury-villa, Stourbridge.
Phillips, Robert Edward, 70, Chancery-lane, W.C.
Poore, Graydon, 49, Queen Victoria-street, E.C.
Purvis, Gilbert, 5, Bow Church-yard, E.C.
Radford, John Charles, 113, High-street, Putney, S.W.
Ryland, Frederick, Westmead, Augustus-road, Edgbaston, Birmingham.
Saunders, George, The Mall, Chiswick.
Simmons, Nimrod, Victoria street, Clifton, Bristol.

Smith, Sir Francis Villeneuve, 19, Harrington-gardens, South Kensington, S.W.
Stenning, Alexander Rose, 121, Cannon-street, E.C.
Tanner, Henry, 15, Whitehall-place, S.W.
Taylor, John, 29, Portman-square, W.
Webb, Henry Barlow, 7, Warrior-square-terrace, St. Leonards-on-Sea.
Whiting, Matthew, Lavender-hill, Wandsworth, S.W.
Willes, W. A., The Manor House, King's Sutton, Banbury, and Arthur's Club, St. James's-street, S.W.
Wonnacott, Thomas, Devonshire-house, Farnham, Surrey.
Wood, Jacob, Lentridge-house, 186, Highbury New-park, N.
Young, Jasper, Mayfield, Clapham-park, S.W.

AND AS HONORARY CORRESPONDING MEMBERS :—
Hayter, Henry B., C.M.G., Melbourne, Victoria.
Von Haast, Sir Julius, K.C.M.G., F.R.S., Christchurch, Canterbury, New Zealand.

The adjourned discussion on the paper by Dr. C. Meymott Tidy, on "Sewage Disposal" (delivered April 14, 1884), was resumed.

The CHAIRMAN, in opening the discussion, reminded the meeting that since the last discussion on this question Dr. Tidy's complete paper had been published, and everyone would agree that it contained a very comprehensive and generally impartial treatment of the most important branches of the subject. It was impossible that on such a subject they should not differ on some points from Dr. Tidy and from each other, but he hoped this discussion would, in a great measure, smooth away difficulties, and that before its close they would arrive at a more thorough understanding of the question than had hitherto been attained. He would add that it was not without difficulty that a second evening had been found for continuing this discussion, if it should not close that night; but Dr. Tidy would naturally require some time to reply to the various points put forward, and, therefore, it had been determined, if necessary, to resume the discussion on that day fortnight, when the general debate would have to close early enough to allow Dr. Tidy proper time for reply. Before calling on Dr. Edmunds to resume the discussion, he would ask the Secretary to read a letter from Mr. Sillar.

The SECRETARY read the following extract from a letter from Mr. Sillar, referring to some remarks, and a table of Mr. Peregrine Birch, (see *Journal*, vol. xxxiv., p. 668) :—"This paper contained an inaccurate, because imperfect, extract from official evidence, and, as such, was calculated to injure the character of the Aylesbury products of the Native Guano Company. . . . In comparing the weight of material put into the sewage with that extracted, he took the figures from Mr. Page's evidence, omitting the important qualification, given in the same evidence, that the former was estimated as containing 46 per cent. of water, and the latter only 14 per cent. Also that the alum used, being soluble, almost entirely disappeared."

Dr. EDMUNDS said they must all congratulate themselves on the valuable paper from Dr. Tidy, which was a classical contribution to the great sewage question, and was not only classical in form, but was of paramount value, containing a mine of information which would always have to be referred to. There was one great principle which had to be settled before dealing with this sewage question. The long and dismal list of failures which had occurred in various towns seemed to have had its origin very largely in the misleading statements on the part of theorists as to the value contained in the sewage of towns. This value when abstracted and put into a utilisable form was one thing, but when encumbered with a vast quantity of water was quite another thing; and it was owing simply to the omission of all regard for that condition of the materials, that there had been such terrible failures. The result had been that local authorities thought that a profit could be made out of cleaning their towns, and the only effect of their attempts was that they got inefficient processes, and then stinted and starved the processes which they did get, and then, of course, failures came directly out of that position of things. Now, the first great principle is this. It is the duty of every town to dispose of its own sewage. Apart altogether from the question of how far that sewage could be utilised so as to lessen or minimise the cost of disposing of it, it was the duty of every town to dispose of its sewage, and to do this without polluting the rivers, and without inflicting any nuisance upon neighbours. For such disposal our towns must be prepared to pay; and any idea of making money out of the ordinary dilute sewage could be no more maintained than the idea of getting a premium for handing over to some one else the privilege of washing one's dirty linen. Then came the question, what it was that had to be dealt with in sewage; and on that point Dr. Tidy had omitted to call attention to one point which was of very great and fundamental importance. The sewage of towns contained, first of all, mere filth; and, secondly, organic germinal matters, whose faculty for multiplying and propagating disease was practically infinite. Those organic germinal matters were really the materials about which the sanitarian was most anxious. The mere filth elements were excessively nasty, and it was requisite that they should be disposed of; but the thing which was of real importance, considering the way in which typhoid fever and cholera were spread, was the proper way of dealing with the particles which, if

they got into water in a certain condition, were capable of multiplying to an infinite extent, and producing all sorts of evils. Now the particles upon which that vital multiplication depended were not in solution; they were particles in suspension in the various sewage liquids. That was a point which must be clearly realised in dealing with this question. He would go so far as to submit that all those organic matters which were in absolute solution had become devoid of all real danger. Nothing that was in absolute solution contained any organic structure, or contained in itself the power of multiplying and re-producing itself after the manner of a seed. In what way had it been proposed to destroy these materials? Fire had been proposed; it had been proposed to get rid of them by throwing them into the ocean; and it had been proposed to oxidise them chemically—possibly to oxidise them in two ways. The use of fire was inapplicable to most of our great towns—to London sewage at any rate. The disposal of the sludge, or sewage, by throwing it into the ocean, seemed a wasteful and sad result. He would condemn that altogether, but the time at his disposal was not sufficient to enable him to deal with all the points. Then with regard to the attempts to oxidise by means of permanganate of soda, he ventured to say that process would be another costly failure. They might perfectly deodorise sewage by an expensive system of chemical oxidation, but it was not practicable by any process of mere chemical oxidation to destroy those particulate organic germs which were the great danger of sewage infection. There was one form of oxidation which had never been dwelt upon with the importance that it deserved, and that was the marvellous carrying power of the oxides of iron. Iron had the power of absorbing oxygen, and of giving up the oxygen again to organic matters with which it was in contact, and something like a continuous oxidation, by means of the oxides of iron, as in animal respiration, might in sewage processes be possible. It was true that the use of iron gave a black discolouration very often indeed to the effluent, and certainly to the sludge; but that was of minor importance if the power of carrying oxygen could be utilised in the oxides of iron. Irrigation was the next great method of disposing of it; but irrigation would not succeed, under all circumstances, at any rate. There was no doubt that if you applied broad irrigation with extreme care, as some one or two men had done in pet schemes, you might do an immense deal, but then you required a particular set of conditions. Take for instance the Berlin sewage farm, which was a model of irrigation; there you had a great area—reclaimed practically from the Baltic—a fine, friable, loamy soil, which could not possibly cohere or crack, and lying upon a dead level with an almost unlimited area. There they had a condition of things under which irrigation would succeed, if it could succeed anywhere. He did not know to what extent the Berlin irrigation was still succeeding, but it certainly was a success some three or four years ago, when he saw it. These conditions could not be obtained in England, near to our great towns, so as practically to dispose of sewage in that way, but if they could, it would of course be a perfect system. With regard to intermittent filtration, that again, he ventured to say, could not be utilised for very much the same reasons. Then we come to precipitation. By the Clark process of purifying drinking water, as might be seen from the North-Western Railway at Bushey, the water in the tanks became of a beautiful blue, and nothing could more perfectly purify a chalky drinking water than Clark's precipitation by lime. But in sewage the problem was different, and lime precipitation was a failure. Still, the formation of a chemical precipitate in the liquid had the power of taking out a very large quantity of fine material which was no part of the precipitate, properly so called; in fact, there was in such a precipitate an appropriating power which made each particle carry down an atmosphere of these fine particles, and there could be no question that the precipitation did a great deal more than was ordinarily supposed by coagulating, entangling, and mordanting, and thus carrying down the fine germinal particles in which the essential danger of sewage consisted. How far could they apply that great principle to sewage? In precipitating sewage matters, they had a much more complicated problem, for, in the first place, the sewage must be deodorised. In all sewage there were putrid gases which must be absorbed, for two reasons—first, in order to deodorise the sewage and make the process tolerable; and next, because while they remained in the liquid, they caused any precipitant obtained to rise and float on the top as a scum, and thus prevented efficient subsidence There was only one thing which would practically absorb these gases, and that was finely powdered charcoal, which could be obtained at a small cost from many manufactories. Charcoal was the one thing that would do that. Then they had to get speedy subsidence. They must entangle and carry down all the fine organic particles. At the same time, they must, as far as practicable, abstract the soluble organic matters. Dr. Tidy had come to the conclusion that the A B C process had given the best effluent with which he was acquainted; and as it had devolved upon him (Dr. Edmunds) by an accident to reopen this discussion, he had gone to Aylesbury and carefully examined this process, and he would recommend any one who wished to undestand the process to do the same. The effluent which he had seen there was a most perfect one; it was absolutely bright, almost colourless and quite odourless; in fact, there was nothing in the effluent but what might fairly and properly be discharged into any stream in the country. There was the offensive sewage running in at one end, and the colourless effluent running out at the other. With regard to the sludge, he had gone

through the process very carefully, and it seemed to him they had a most admirable result there also. The A B C process gave a sludge which could certainly be sold, and that was a result which no other process had succeeded in attaining. This sludge did not decompose and putrefy; yet, at the same time, if a little milk of lime were mixed with the native guano, you got an evolution of a large quantity of ammonia, which was palpable to the nose. That showed they had a large amount of ammonia contained in the sludge-cake made by this process from the sewage. They knew that could not have been precipitated as ordinary chemical ammonia, because there was no precipitant for ammonia. The explanation of it was this, that you got all these germinal matters containing stiuctural nitrogen entangled and carried down into the sludge, and in such a condition that by a subsequent slow process of ripening, the ammonia was released and combined chemically with some of the other materials in the cake. With regard to the process going on at Aylesbury, there seemed to be a little superstition in the use of blood with the sewage. But, by the addition of a small quantity of albumen, they really introduced the material which was used for the fining of wine, coffee, and all organic substances, and he would beg them to consider whether they had not here stumbled upon a very valuable adjunct to the precipitating processes for getting rid of these materials in the use of blood. What was done was this. There was a mixture of charcoal, albumen, and clay, and these three things mixed together were disseminated into the sewage as it flowed into the works. There could be no question that this first addition did deodorise the sewage perfectly. No one could doubt or deny that. From some superstitious idea also clay was at first introdnced; but it certainly was of use in weighting the flocculi. After this mixture had been thoroughly blended with the raw sewage, a small quantity of acid salt of alumina was thrown into the liquid, and that again was thoroughly blended, with the result that the alumina was thrown out in flocculi which were made more tenacious by the albumen; these were disseminated through the sewage in a few minutes. If some of the sewage treated in this way was stood in a jar, it would be seen that in seven or eight minutes almost the whole of it would subside, and leave a clear inodorous liquor. As a medical officer of health, having no interest in in any particular process, he certainly was of opinion that the A B C was a valuable process, and that no no one could fairly judge of it unless they had not only studied it in their laboratory, but had seen its practical management by the Native Guano Company.

Mr. SILLAR said that, after the remarks of the last speaker, it was hardly necessary for him to say much in favour of the A B C process, because his remarks would no doubt be received as those of an enthusiast, he being connected with the process; though why a man should not be an enthusiast when connected with a great cause he could not understand. The A B C process had been in existence for twenty years, and during this time it had met with great opposition, so that he might perhaps be pardoned for calling attention to what had been done by it. Was there any other process which solved the three great problems, viz., an effluent water fit to go into the river; the process carried out without any offence to the neighbourhood; and a deposit of agricultural value? No treatment of sewage ought to be considered complete unless it provided for the agricultural utilisation of the deposit. It might not be of much consequence receiving a golden medal for a process, but he might point out that the A B C process had received a medal from the Fisheries Exhibition, the Health Exhibition, and the Royal Agricultural Society, thus showing that they had solved the three great problems to which he had referred. He was not aware that the advocates of any other process had unreservedly placed their mode of working at the disposal of scientific men, but the A B C process had been inspected by Dr. Tidy and Professor Dewar, who had given a report upon it, which was set out in the *Journal of the Society of Arts*. He hoped the discussion upon this question would not begin and end in talk, but that some practical result would be arrived at. The facts had been laid before them, but that meeting was neither judge nor jury. The Metropolitan Board of Works was the authority to judge and to give the verdict upon any system, and then to see that the best system was adopted. The Metropolitan Board of Works had taken a great deal of pains with the matter, but he might perhaps be permitted to point out what they knew about it. Mr. Dibdin, during the discussion, stated that he had "examined all the processes before the public, and, was now thoroughly convinced that no process of precipitation, whatever quantity of chemicals were used, or whatever chemicals practically available were used, materially affected the dissolved matters" (see *Journal*, vol. xxxiv., p. 671). Mr. Dibdin entirely contradicted Dr. Tidy in this respect, but, to his certain knowledge, Mr. Dibdin had never seen the process at work. All the adverse remarks about the A B C process were from people who had never seen it in operation, while all the favourable remarks were from people who had taken the trouble to inspect the system. Dr. Dupré differed from Dr. Tidy (which he had a perfect right to do), and said that, according to his experience, no precipitation process yet brought forward sensibly did more than clarify the sewage; and he gave some figures showing how little effect this process had on organic matter, but the curious thing was that, to his knowledge, Dr. Dupré had never been down to Aylesbury to see the process at work. It had been said by other persons that the effluent water was worse than the sewage as it entered the works; but it was time that such astounding statements should cease to be made. Was it to be supposed that so many eminent

gentlemen had entered into a conspiracy to cajole the public by saying that which was not true. Another gentleman, who was decidedly opposed to anything but his own theory, was Colonel Jones; he was a staunch irrigationist, and had been perhaps more successful than anyone else in carrying out that method. Still, after going down to Aylesbury, he gave his unqualified approbation to the A B C process. The only two things he found fault with were, first that they asked too much for the native guano; but if people were willing to give the price, he did not see why they should not get it, or even more if they could. The other objection was that the Stock Exchange afforded opportunities for gambling. This he did not dispute, but he did not see that that affected either the purity of the water, or the value of the manure. The Stock Exchange gave facilities for gambling in the shares of Guinness and Co., but he could testify, nevertheless, to the good quality of the stout. Mr. Baldwin Latham again, who was a man of very varied experience, said he had no particular principle to advocate, but the A B C process was notably successful; he had adopted it in certain cases, and found it very satisfactory. Was there any reason which did not appear why the Metropolitan Board so steadily ignored the A B C process, and had not given it any thought whatever? Was there any animosity that the Metropolitan Board of Works had against the A B C process, or against the Native Guano Company? If it were the latter, he was sorry for it, but that ought not to militate against the efficacy of the A B C process. He hoped public opinion would be brought to bear upon the question, to say that this A B C process really did what all its advocates said it did. It, at any rate, ought to have a fair trial by the Metropolitan Board of Works. There was no animosity on the part of the Native Guano Company towards them; for even, in spite of the way they had been treated some years ago at Crossness, they had offered to the Metropolitan Board that, if there were any idea of trying the A B C process, they would again, at their own expense, demonstrate its power at their works at Crossness. He rather thought—it was only supposition—that the animosity which the Metropolitan Board showed to the Native Guano Company was an exemplification of that old Latin proverb, *Proprium humani ingenii est odisse quem læseris.*

Dr. Carpenter said it would be utterly impossible for him to expose the fallacies that he considered were contained in Dr. Tidy's paper in the short space that would be at his command. He was not going to analyse that paper with reference to any of the remarks which it contained upon the principles of precipitation, or the chemical processes that the writer advocated. He believed that those chemical processes might be advantageous. The observations he had to make would be rather upon the criticisms that Dr. Tidy had thought proper to pass upon irrigation, and the animosity which seemed to go through the whole of the paper against irrigation. He had watched all the processes more or less connected with the utilisation of sewage. He had seen them in various forms and various conditions, and he could say, with the utmost satisfaction, that the only arrangement in connection with sewage that would fulfil all the requirements which a town had a right to demand, was the utilisation of that sewage by irrigation. In every other way there would be evils which, sooner or later, would be felt, and would be opposed by the neighbours immediately around the works. But with regard to irrigation, if the irrigation was carried on properly, and as it ought to be, there would be none of those objections which undoubtedly did arise when irrigation was not carried on in the proper way. Because irrigation sometimes was not carried on in the proper way that was no argument against it. Because accidents happened on railways, railways were not to be stopped; it was the accidents that had to be stopped. That was the position which those who were promoting the utilisation of sewage ought to take up. Dr. Tidy started first of all with a general conclusion to some extent in favour of earth-closets. The earth system, it was said, had a certain definite advantage over water-closets; there is no connection with the spread of disease, and no pollution of water courses in connection with earth-closets. He differed from Dr. Tidy. He had had numerous instances brought to his notice in which earth-closets had been removed because of the evils which they had introduced into the system, and water-closets had been substituted. He did not know of any converse case where a town, having had water-closets introduced, had done away with the water-closets and introduced earth-closets or the pail system, or any other. That was a very important fact in considering this question. It meant that the people preferred, when they got used to water-closets, to have water-closets, and he believed that so long as people dwelt in towns water-closets would be in their midst, and what they had to do was to provide for the evils which were connected with their use. What were those evils? They were connected, in a great measure, with difficulties in the way of administration, and in the way of getting rid of the sewage out of the towns, and for those difficulties he was obliged to confess that their engineers were, to some extent, responsible. Throughout Dr. Tidy's paper he referred to the putridity of sewage which had been again referred to that evening by Dr. Edmunds. Putridity and putrid gases had been spoken of as being the natural accompaniment of sewage. He contended that they were no accompaniment whatever naturally, and had no business to be there. He was of course only speaking of a town which complied with the required conditions with regard to health, and had all its sewers so constituted that the sewage would get down away out of the town. Even London, with all its immense area,

ought to have the whole of its sewage taken out of it within twelve hours; and if the sewage were taken out of it within that time, and properly treated either by precipitation or irrigation (he contended that the latter was the right way where it was possible to get land), in either case there would be none of the putrid gases that had been spoken of. There would not be any decomposition of the sewage at all. One of the points which all sanitarians ought to aim at was to get the sewage out of the towns as rapidly as possible, and not to allow sewers to exist that were sewers of deposit. He was bound to say that that was not the condition in which sewers were in the majority of instances. The point that they should first direct attention to was that the sewers ought to be kept as clean as back kitchens were, and there was no reason why they should not be. If they were properly constructed, and all the arrangements in connection with them were carried out in a proper manner, there would be none of those difficulties which were connected with putridity. Dr. Tidy spoke somewhat in antagonism of the separate system contending that a separate system robbed the sewers of one of the means of natural and effectual flushing, such as occurred after heavy rains. He (Dr. Carpenter) objected to that kind of flushing. If sewers were constructed as they ought to be, and as they were in some districts, so that they were completely flushed clean with the natural flow of sewage, and had a self-acting flushing tank to occasionally give them a full flow at stated intervals, there was no occasion whatever to introduce storm waters into them. With regard to cities like London, he granted that it could not be helped; the condition of the streets themselves was such as required that the storm water from those works should go into those sewers, and the sewers must no doubt be made large enough to comply with the conditions that would arise in connection with those storms. But with regard to towns generally, the introduction of the storm waters, unless the population was very dense, ought not to be allowed by those who were arranging for the utilisation of sewage. If that were carried out, they would in a great measure get rid of many of the difficulties that attended the management of sewage farms. Dr. Tidy spoke of the difference in those towns in which there were water-closets, and those where no sewage went into the sewers at all, and seemed to think that if the human excreta were kept out of the sewers, one of the difficulties would be got rid of. Now there was the evidence contained in the report of one of the Royal Commissions, to the effect that the sewage of towns where the excreta was kept out of the sewers did not differ from the sewage of towns where the whole of it went in. Dr. Tidy himself, in his paper, pointed out that one horse produced fourteen or fifteen times the amount of ammonia, or of urine, that was excreted by a human being, and no doubt the urine of horses, and the washings of houses, must go into the sewers, even if the human excreta were kept out, and they could not help having in that sewage constitutents that would be likely to spread mischief if allowed to go into the rivers to pollute them. Therefore, Dr. Tidy was rather blowing hot on the one hand and cold on the other. The paper also referred to the value of sewage, and Dr. Tidy did not contradict that there was a value in the sewage, although he pointed out that there were very great differences of opinion with regard to that value. No doubt there were very great differences with regard to the results that were obtained from the utilisation of sewage, but that which was done on one occasion could be done on another if proper means were taken for the purpose of utilising the sewage. He was acquainted with farms which had been under irrigation for the last twenty-five years, and he knew that the land was as competent and capable of dealing with the sewage that was put upon it at this moment as it was twenty-five years ago, when it was first put down for sewage irrigation. That land, at this moment, was capable of producing as heavy crops as it did when it was first utilised. The crops were as perfect this year as any that had ever been grown there, and the quantity of the material that was taken off the land had been its 40 tons of rye grass, or its 40 tons of mangolds or roots, per acre. That showed that material of value could be got out of the land. It was true Dr. Tidy seemed to regard it as Dr. Letheby used to speak of it, as being dropsical, and not so efficient in its feeding powers as material that was obtained without the use of sewage. The result of experience in connection with the utilisation of sewage, and its use by animals, proved that the animals liked it, and were fond of it. He could say that from analyses of the milk that had been obtained from cows that had been fed entirely on rye grass. These analyses had been carried out at Somerset-house, and they were of a better character than analyses of similar milk obtained from ordinary agricultural farmers. Of course, there were very great difficulties put in the way of the irrigation system; difficulties had been put in his way when he had to do with the management of a sewage farm. Dr. Tidy said in his paper that milk in connection with a sewage farm was likely to become sour sooner than other milk. That was directly contrary to experience. When he became acquainted with the Croydon sewage farm they had some difficulty in getting rid of the milk, because there was a prejudice against milk obtained from a sewage farm; so much so that it was found necessary for those who took it not to let their customers know that it came from a sewage farm. He went round amongst his friends, and induced a number of them to have delivered at their houses one gallon a day for 1s., the price in the market at the time being 1s. 4d. or 1s. 5d. A large number of people were got to take their one gallon a day, and, when once they commenced with it, and had given their children the milk, they con-

tinued its use. After a time they met with considerable antagonism from the milkmen, and ultimately an arrangement was come to by which one milkman took all the milk that the farm could produce. He knew, from personal experience, that the children who took the milk were never troubled with any of those illnesses which were said to be due to bad milk, and there were never any complaints of the milk, which was delivered once a day, becoming sour. That was a proof of its power of being assimilated by the body, and that it was of a perfectly desirable character in point of health he knew from examination of the families who took it. They had now no difficulty in Croydon with regard to the disposal of their milk from the sewage farm. The feeling against it had been quite got over; and he could assure Dr. Tidy that there never was a single symptom or sign of any of that milk going bad at all. There were a large number of similar arguments, with which he had not time to deal. With regard to the quotation in the paper on Dr. Creasy's observations about the neighbourhood of sewage farms, Dr. Creasy had himself contradicted that, and admitted that he had been mistaken. Then there was the argument mentioned of Dr. Clouston with regard to the Cumberland Asylum. There were few asylums in the kingdom, at any rate he did not know of any having been established during the last twenty years, that did not use irrigation for the utilisation of their own sewage. With great numbers of them the sewage was utilised close up to their very borders, and no evil had ever arisen of the kind which Dr. Clouston supposed to have existed at the Cumberland Asylum. Then Dr. Tidy quoted Mr. Hawksley's statement that sewage irrigation in hot weather was very unhealthy. He (Dr. Carpenter) had examined into the matter, not with the intention of ever being an advocate one way or the other, but having no interest except the truth. In his neighbourhood they had had unhealthy seasons; he had watched the health of the *habitués* upon the farm, and he had seen several hundreds of them, and watched them very carefully at a time when, by an unfortunate condition of things, they produced a large quantity of typhoid fever in consequence of the impurity of the water. That typhoid excreta went on to the farm; there were 1,200 cases; he carefully watched the people on the farm, and there was no illness whatever produced—not a single case of typhoid ever arose in connection with that epidemic amongst those who were on the farm, although the weather was pretty hot on some days. Then Dr. Tidy was of opinion that there were very offensive smells. Whenever there were offensive smells from a sewage farm, the people who were managing it failed to do their duty. There ought not to be any kind of offensive smell from a sewage farm. He had, over and over again, when they had 500 or 600 acres under irrigation, found that, at certain times, there was no smell that could be noticed by anyone. There were other times when the manager, who was paid 30s., or £2, or £3 a week wages for looking after an immense area of that kind, had failed in his duty, and had allowed a smell to arise. The management of these farms was not, as a rule, in the hands of scientific men; they were managed by people who did not know what they were about. As soon as a man had been in the service of a Local Board for any time, and had found how to deal to some extent with the sewage farm, somebody else came on to the farm—some tailor, or linen draper, or licensed victualler—who, of course, knew a great deal better how it could be done than those who had been long engaged in the work. The man who had begun to know was ousted, and somebody else who knew nothing whatever about it was put into the management. Those were the reasons which led to so many failures in sewage farms; but he would cite to them the case of Croydon, where the sewage of that town was utilised on 600 acres of land, and when the farm was doing its work efficiently. He could not pretend that it paid, if the enormous sums that had to be paid for the land were taken into account. Sewage farms would not pay where they had been overweighted with enormous sums which had had to be paid for compensation and for the passage of Bills through the Lords and Commons, and so forth. But if the land for sewage farms could be had at agricultural prices, and it was farmed properly, it would be found to give satisfactory results. No doubt the ordinary farmer could not farm a sewage farm; it wanted peculiar treatment. Dr. Tidy did not seem to be aware of that, because he spoke of it interfering with the maturing of the crops. There ought never to be any crops to mature on a sewage farm proper. It was a mistake to allow anything like maturing. The only object that should be had in view, with regard to sewage farms, was the production of rye grass and of roots, and the using of those materials as fast as they could be used. The arguments put forward by Dr. Tidy had been communicated to some members of the Local Board of Croydon when they had a Local Board. It was thought that it would not pay to keep milch cows, and it was said that the produce of the farm ought not to be utilised on the farm, but should be carried four or five miles away. Accordingly, the cows were got rid of, and the grass went to seed, and the members of the Local Board were surprised to find whole fields or hundreds of acres of rye grass which, being allowed to flower and to mature its crops, so to speak, were utterly useless for the purpose of purifying the sewage. They discovered that to their immense loss, and that had been the case with almost all farms. But at this moment they had at Croydon one of the finest herds of cows ever seen in the country, that were fed upon grass from the sewage farm, and they gave a better supply of milk than could be produced from any other herd of a similar number, and the

milk was of the purest possible character. Again, there was a magnificent herd of cows at Birmingham, and splendid results were obtained from sewage irrigation there. Having regard to those facts, was it proper to waste the products which nature gave, and destroy them so that they should not produce the material? In Croydon, land which, when he first knew it, was worth 20s. per acre, was now worth something like £10 or £12 an acre. The owners of that land had been made rich men, for the Local Board had bought it all at an average of £300 an acre. The farm had paid Poor-rates to the parishes in which that land existed on a rateable value of £9 an acre. They employed six times the number of hands that had been employed upon it before; and they provided five times over the amount of material for that land that had been produced before, in the way of meat and milk, for the people who lived in the neighbourhood. He contended that that was a great national gain, and it had been accomplished at a cost to the parish of not more than a 2d. rate. The difference between agricultural land and land taken for sewage farm purposes must be paid by the community. Then there were the national advantages to be borne in mind that followed from such a source of production of meat and milk. History always repeated itself; suppose some day England went to war with some foreign power, and the command of the seas was not entirely her own; there would be a difficulty in getting meat or any food at all. Yet, if (to take London as an example) the sewage of the three and a half millions of people in London, that was now poured to waste, were conveyed on to some of the barren land which existed all round London, there would be some 50,000 or 60,000 acres which were now producing nothing which would produce enormous quantities of milk, that poor people wanted, and enormous quantities of meat that would be available for them. Therefore, a town ought not to be allowed, as a matter of duty to the nation, to have the constituent parts of the sewage destroyed, either by throwing it into the sea or by any other of the processes which were looked upon with so much favour by Dr. Tidy. Some of those processes might perhaps be used; for instance, he quite approved of the combination which was being carried on at Birmingham; but the idea of utterly destroying the sewage, or, as the Metropolitan Board of Works proposed to do, of carrying it away and throwing it into the sea, was perfectly monstrous. The sewage ought to be applied to the land, and ought to be used for the purpose of producing the materials that were wanted for it. It was the duty of the country to protect itself by making the land more capable of producing the material that ought to be brought from it, rather than to allow it to be run to waste and to get nothing from it, whilst the foreigner had to be looked to to bring us in phosphates and those manurial materials which could not be done without. There were many other points which he should like to have taken up if time had permitted.

The CHAIRMAN said he should be very sorry if Dr. Carpenter omitted to criticise any portion of Dr. Tidy's paper which he thought required it, and there was certainly one paragraph which he expected him to have dealt with, namely, the one dealing with the pollution of rivers. It must be borne in mind that there were two aspects to this question, one connected with the value of the product, and the other with the purity of the effluent, and he should have liked to hear what Dr. Carpenter had to say with regard to the paragraph at page 1179 of Dr. Tidy's paper, in which he said, "In all irrigation schemes, of whatever nature, we are dependent for effective purification on effective land in effective order. The action of land may become ineffective from circumstances over which we have no control, namely, frost, where the ground may become absolutely impenetrable and water-logged in times of heavy rains, when the sewage is in far greater quantity than normal, and for a time at least more foul than normally from flushing of the sewers." He did not think anything Dr. Carpenter had said would lead to the conclusion that he was of a different opinion on that point. Those were practical difficulties which were fairly put forward by Dr. Tidy.

Dr. CARPENTER said with regard to frost, Dr. Tidy was quite mistaken. He had watched sewage farms when a frost had lasted for six weeks, and though he would grant that the effluent had not been of that perfect character that it was on other occasions, it was still perfectly fitted to go into a running stream, and not likely to produce mischief. Any farm that was allowed to get water-logged was badly managed; it was utterly impossible for a farm to grow produce properly if it were allowed to get water-logged. One hour after the sewage stopped flowing the land ought to be comparatively dry on the surface. Again, Dr. Tidy had referred to Dr. Cobbold on the question of the entozœa, and he believed that Dr. Cobbold did bring before the Royal Society a paper dealing with the subject; but he had in his possession a letter from him, in which he informed him that he was quite mistaken in regard to the results he had then come to. He (Dr. Carpenter) had written to invite Dr. Cobbold to come and see some animals which he was about to kill; and he wrote to say he was sorry he could not come, but he was satisfied, from what he had seen since, that his fears with regard to sewage farms were comparatively groundless. Dr. Tidy also stated that the difficulties of sewage farming were tremendous, and he would grant the difficulties were tremendous in connection with the management by committees, usually of gentlemen, connected with the local authority who were not in any way scientific men. They generally put at the head of affairs an ordinary farm bailiff at a

low salary, and expected him to manage one of the most intricate problems of science in connection with farming, because if you did not adopt proper means for obtaining from the land a sufficient amount of material corresponding with the amount of phosphates and ammonia put on to it, it would fail. He found it was necessary to get off so much produce according to the amount of sewage put on, and if he did not, there was something wrong. Dr. Tidy also spoke of the farm as not in any way showing that the sewage got into the ground, and there he could quite corroborate him. The sewage did not go any depth into the ground, and that was the difficulty with intermittent filtration. Sewage was kept within the first three or four inches of the surface, and it was absolutely necessary that the ground should rapidly dry by means of proper channels. That bore also on the question of frost. Dr. Tidy stated that vegetation did not go on in the winter; but there he could not agree with him. Vegetation was continually going on, and a large amount of organic matter was fixed in the roots of the plants ready to be utilised the moment warm weather came; and, as a fact, there was a crop of sewage grass on irrigated fields long before it was possible to get one on an ordinary field. A farm to be managed properly must have land always under rye-grass cultivation; and if the area were not sufficient, there should be a portion which could be used for filtering, but if the area were large enough, the necessity for filtering would not arise. The great point was not to let the land get water-logged or deprived of atmospheric air, and it must be broken up pretty often, so that the air would get in. He had seen cases where the sewage was allowed to go on the same plots for two or three days, or even two or three weeks, and then they wondered they could not get a crop. No sewage should go on to one plot for more than 12 hours, and then should be turned on to another, and the air must be allowed to get to the roots of the plants. Again, the land should never go beyond three years without being broken up, and it was the failure to do this, in order to avoid interrupting the cropping of the land, which often led to difficulties with local authorities. That was a fault on the part of the farmer, not of irrigation. Irrigation was the right thing, and it was even better to pump than to send the sewage into a river or out to sea. If they could do it as the A B C Company did, well and good, but with regard to the advantages of irrigation over that plan, for the sake of the country, he was satisfied that irrigation ought to be encouraged first, and no other plan tried until that was shown to be impossible. All the Commissions which had been instituted by the Government recommended irrigation, and they were conducted by scientific gentlemen, who had no object in view except to get at the truth. Dr. Tidy's object appeared to be to put down irrigation, and set up precipitation. It might be retorted that he was the advocate of irrigation against precipitation, and he was quite willing to accept that position, and wished he had the opportunity of answering Dr. Tidy more in detail.

The CHAIRMAN said he had already referred to the fact that there were two aspects to this question, one of which Dr. Carpenter had so ably dealt with, of turning the sewage to advantageous account, and the other the disposal of sewage with reference to compliance with the present condition of the law. One point referred to by Dr. Tidy was the question of the desirability of having standards in order to comply with the condition laid down in the Rivers Pollution Act, that persons dealing with sewage had to show to the satisfaction of the authorities that they were using "the best practical and available means" to render harmless the sewage matter flowing into the stream. Dr. Tidy had to some extent criticised the proposed standards, and referred to certain practical standards which he thought might be introduced. On this point he thought it would be very useful to hear a few remarks from Mr. Alfred Fletcher, chief inspector under the Alkali Works Act, and also inspector of rivers under the Rivers Pollution Act in Scotland.

Mr. ALFRED E. FLETCHER said there were various ways of treating sewage, either by precipitation, and then irrigation, the effluent finding its way into the stream, or by irrigating the land with untreated sewage, when again the effluent found its way into the stream, or by collecting the sewage matter in a more or less solid form, and reducing it ultimately to a complete solid capable of easy transport, and thus putting it on the land. With regard to the condition of the effluent reaching the watercourses, and the question of adopting standards, to enable inspectors to pronounce on the efficiency of the treatment, difficulties arose from the varied character of the streams. If the effluent passed into a small stream used for domestic purposes, its condition must necessarily be watched much more strictly than if it went into a large river not so used, or which had already become tainted in so many ways that it was hopeless to consider it as potable water. It would, therefore, be very difficult to frame standards which should apply in all cases. All that human wisdom could do to prevent or abate a nuisance was to provide that the best practicable methods should be used. Every one should be willing to do his best, and the law aimed at compelling him so to do. The question was, what was the best, and whether there could be an elastic standard which should vary with the circumstances. It seemed to him that those words, "the best practicable means," were not so loose as they appeared to many at first sight. One had not only to contemplate the pollution of rivers from sewage, but also contamination from all sources, and if an inspector considered the water coming into a stream was of so foul a nature that something must be done with it, and he found it was much worse than an effluent from

other places of a similar character, he was not necessarily to come forward and say, You must adopt this or that plan; he merely took the place of a critic, and said, this is not as good as it might be, because he had seen other instances where a better result was obtained, and by maintaining that position he drove the person interested to find some better method. The difficulty of framing a standard was that no one could predict all the varied conditions that might arise, but when the points were compared, and people's thoughts were directed to the condition of an effluent, the standard at length formed itself, and crystallised out of the somewhat vague term, "the best practical methods." To illustrate this, he would mention a standard which had been arrived at in Scotland in connection with the effluent water from an oil works by the joint efforts on the one side of a chemist representing the works, and, on the other, by one representing those who were interested in the condition of the streams. By continued discussion, and improvements in various directions, they at last arrived at an agreement as to what should be the standard for the effluent water from the particular works on the stream, and it was as follows:—Take twenty ounces of the water, distil off one ounce, then add soda, and distil off another ounce, then acidify with sulphuric acid, and distil off another ounce. Those three ounces to be added to fifty ounces of Edinburgh water, and they were not to render the same unpalatable. That was a very complicated standard, and could only have been arrived at after long discussion and experiment. It grew out of the obligation to use the "best practicable method." Similar endeavours should be used to prevent the pollution of rivers as to prevent the pollution of the atmosphere in the case of gases. With regard to the Rivers Pollution Prevention Act, he might mention among its anomalies that the only duty imposed on the inspector appointed under it was to nullify the Act. Instead of his duty being to look after sources of pollution and see that they were corected his most prominent duty was to grant a certificate, if he believed that a manufacturer supposed to be polluting the water was not doing so. If the inspector gave him a certificate to the effect that he was using the best practicable means, that would last two years, and during that time he was protected from the action of the law. Under the Alkali Act, which was the model Act in this direction, inspectors were appointed, whose duty it was to be always on the watch, to inspect works likely to pollute the atmophere, and to bring wrong-doers to justice.

Mr. Bernard Dyer remarked that, although the paper dealt with the general subject, a good deal of discussion had naturally turned on the question of the sewage of London; and on that he would say a few words. This question was very thoroughly discussed recently by a Royal Commission, when a large amount of evidence was taken; and two years ago that Commission published its final report. That report contained certain recommendations, the first being that the suspended matters must be removed by precipitation, but that though, as a temporary measure, the effluent might go into the river, it would not be sufficiently free from noxious matter to allow of its being discharged at the present outfall as a permanent measure; but that it would require further purification, and this could only effectually be carried out by application to land, in the form of intermittent filtration. Failing to find suitable land near at hand, it was recommended that it should be taken down the river and discharged. The Metropolitan Board of Works had thought fit to put aside these recommendations, and to set to work to discuss measures for precipitation at the outfall. With the aid of certain eminent chemists they had devised a scheme for the so-called purification of the river by turning into it with the effluent in hot weather certain positively large, though comparatively small, quantities of manganate of soda and sulphuric acid. One might admit that such a measure might effect sufficient oxidation to prevent immediate nuisance at the outfall, but as a chemist he must protest against the notion that any kind of tinkering with chemicals at the outfall was likely to prevent a sewage effluent charged with putrescent matter from putrefying in the river. The sewage water was not carried directly out to sea, but oscillated with the tide, and even though the solid matter might be removed, the river mud became saturated with water, containing this effluent, and must be liable to produce a nuisance at low tide, although not so great a one as under the old state of things. Looking over the various schemes which had been proposed, he was inclined to advocate the Canvey Island proposal of Mr. Bailey Denton and Colonel Jones as more likely to meet the difficulty than any other. There were there 3,000 acres of land, below the level of high tide, capable of being converted into large earthen basins; where there was plenty of room for precipitation, and ample materials—sand and earth of various kinds—from which filtering beds could be constructed; and through which the effluent could be finally filtered before being discharged into the river. Mr. Bailey Denton calculated that that area would take the sewage sludge of London for 100 years, calculating the daily outflow at something like 200,000,000 gallons, instead of 150,000,000, the present quantity. There was plenty of other land in the neighbourhood which might be used for the same purpose in future. Of course the scheme would involve great outlay, but Mr. Denton calculated that the interest on the original outlay and annual expenditure would not cost much more than the rate of 1½d. in the £.

Dr. Arthur Angell (Southampton) said he had expected there would be a sort of battle between the advocates of precipitation and irrigation, and just now they seemed to be coming almost to close

quarters. He had listened with great attention and pleasure to Dr. Carpenter's remarks, in which he seemed to claim all the beef and all the milk on the side of the irrigationists, but that was not quite so, because there were well-known processes of irrigation by which beef and milk were also obtained. It depended on the question whether or not the precipitate produced was utilised. They had already had evidence that that was the case with the A B C Company, which sold its sludge for agricultural purposes. Still, no doubt, they would admit that a large quantity of the ammoniacal liquor went into the effluent, and therefore that did not prevent the irrigationists coming in and doing some useful works. Dr. Edmonds had claimed that the A B C Company was the only one which was able to sell the sludge, but at Southampton also sludge was produced, for which they had numerous customers, and their orders were a long way ahead of their production. It was a comparatively easy thing to get up a small fictitious business with a few customers, who had not come before, but when the customers tried your wares, liked them, and came again, you might conclude that the product was worth buying. The process in use at Southampton had been explained at a large sanitary meeting. They used a material not much unlike that of the A B C Company, though the latter seemed to have considerably changed their formula; and the effluent was sufficiently good to flow into the estuary of Southampton, and they were carrying out their process at an economical rate. It was so arranged, in conjunction with Fryer's distributors, that the sludge, in cases of pressure, bad weather, or epidemic, could be burnt. They were now burning the whole ordinary refuse of the town, and he had seen the actual burning of the sludge sufficiently long to know that it could be done, though, of course, so long as they could sell it they would not have recourse to that process. The irrigationists, he thought, might take it as some consolation that their function would always exist, even though precipitation should take the first position in the science of sewage treatment; for where a really first-class effluent was required, there was no better method than taking it on to land, and so getting a perfectly pure effluent to flow into the river.

The discussion was then adjourned to Wednesday, the 15th instant.

Miscellaneous.

EXHIBITION FINANCE.

The following particulars are obtained from *The Times*:—

The principal Exhibitions held up to the present time have been—London (1851 and 1862), Paris (1855, 1867, and 1878), Vienna (1873) and Philadelphia (1876). It has not proved easy to get hold of actual balance-sheets of all the foreign Exhibitions, but sufficient information is available about all o them to enable a fair comparison to be made, and of our own two full particulars have been published in the reports of the Royal Commissions appointed for each Exhibition.

The total receipts for the 1851 Exhibition, amounted to £506,243, of which £186,000 was surplus profits. This total was made up of £423,792 for admissions, £67,896 subscriptions (which many thought ought to have been returned), together with payments for the refreshment contract, &c. As there were 6,039,195 visitors, the amount received at the doors represented about 1s. 5d. a head. The buildings cost £169,998, maintenance and police £24,524, personal services £67,309. The prices of admission were 5s., 2s. 6d., and 1s.; there were also two days at £1. Though there were 27 5s. days and 30 2s. 6d. days nearly four-and-a-half of the six million visitors paid their shilling at the doors.

In 1862, the total receipts were £459,631. This amount was insufficient to meet the outgoings, and, in order to avoid a call on the guarantors, the contractors, Messrs. Kelk and Lucas, reduced their claims by about £65,000, and Mr. (afterwards Sir John) Kelk made a donation of £11,000 to the funds. In consideration of the abatement the contractors took over the whole of the property of the Commission. The admissions amounted to £408,530 the refreshment contract to £29,285. The chief items of expenditure were—buildings, £329,001; roads, £13,358; salaries, £45,778; police, £19,435. There were 6,211,103 visitors, and they paid a little less than those in 1851, 1s. 4d. a head.

Of the three Paris Exhibitions, none was a financial success, but as they were all Government undertakings, this was probably not considered a matter of the greatest importance by the projectors. In 1855 the charge for admission was on several occasions lowered to 20 centimes, and there was one actually free day. The result of this was that 5,162,330 visitors only paid £128,099. In 1867, 6,805,969 visitors brought in £420,735, but the expenses were heavier. In 1878 the expenses were enormous, and the deficiency is stated to have been considerable (the receipts were £206,477, the number of visitors was 6,740,500). The same is also understood to have been the case at Vienna in 1873, when there were 6,740,500 visitors, with a financial result of £206,477.

The accounts of the Philadelphia Exhibition are complicated by their connection with the purchase of Fairmount Park for the city, and also by the arrangements under which the necessary funds were obtained by the issue of stock. They are, however, set out in full detail in the reports of the Centennial Commission. From these it appears that 8,140,193 visitors entered the Exhibition, and paid £798,675,

or about 2s. each. The charge for entrance was 50 cents (a little more than 2s.). The actual result of the Exhibition was a financial success, but the funds of the Centennial Commission consisted in part of donations and appropriations, and these would have to be taken out to get at the real commercial outcome of the Exhibition.

If the accounts of the Fisheries and Health Exhibitions be summarised in the same way, we find that the Fisheries had a gross receipt of £162,903, of which £117,869 was obtained by the admission of 2,703,051 visitors (about 10d. each), and £8,702 was subscribed; over £11,000 of the rest is rent, paid or to be paid by the Health and by the Colonies. The Fisheries buildings cost £44,238; their electric lighting, £10,397; salaries and wages, £14,098 (including police); conferences, juries, and jury awards, £11,288; music, £5,255; gardens, £3,740. The surplus was £14,752.

The Health Exhibition had a total receipt of £237,048, of which £178,509 was derived from 4,153,390 visitors (about 10d. each). Donations amounted to £11,824. £12,023 was a merely nominal asset, since it represents an amount due from the Inventions for buildings and plant, but remitted. New buildings, including Old London, cost £47,045; electric lighting, £23,140; rent, £16,888; and rates and taxes, £1,573. Salaries and wages, £21,987; juries and conferences, £7,832; music, £14,181; gardens and illuminations, £7,611. The Health surplus was £15,580.

As regards the Inventions, we only know that the total receipts were £208,490, against an expenditure of £213,927, leaving a deficiency of £5,437, which may be extinguished by the adjustment of matters now outstanding with the Colonies.

In comparing the recent and the older Exhibitions, it should be borne in mind that the latter were always closed at dusk, and that the heavy charges for artificial illuminations were, therefore, avoided; also that the cost of the garden illuminations and of the illuminated fountains is additional.

To the above may be added the statistics for the Sydney (1879) and Melbourne (1880) Exhibitions. At Sydney there were 1,117,536 visitors, the receipts being £40,432. At Melbourne there were 1,330,279, and the receipts were £46,952.

COLONIAL WINES.

By Richard Bannister, F.I.C., F.C.S.

In the International Health Exhibition of 1884 colonial wines attracted considerable attention, and although the number of exhibits was comparatively few, the quality of several of the wines from Australia and the Cape received favourable commendation from the jury, and the whole assortment gave promise of future success in wine production. It was only to be expected that in the Colonial Exhibition there would be a large assortment of wines of colonial manufacture, and that both in number and variety the exhibits would greatly exceed those displayed in the Health Exhibition of two years ago. This expectation was more than realised, for not only at the stalls in the different courts, but also in the cellars underneath the Albert Hall, there was such an array of casks of wine from the Australian Colonies and the Cape, that it appeared more like the establishment of a large wine importer than the display of specimens for an exhibition of wine. The growers and importers acted wisely in exhibiting wine in bulk as well as in bottle, for the good condition of wine in cask will do more to promote confidence in the keeping qualities of wine than the most exhaustive tasting in bottle could ever do. And not only was this done with wines sufficiently matured for immediate consumption, but in certain cases wine of 1885 vintage was brought over, so that those who wished to submit colonial wines to a most searching examination might have the means at their disposal for so doing. It is only right to say that this trying ordeal has been passed through in a very satisfactory manner, and that many specimens of these wines have been reported upon very favourably by those competant to judge. The public have also approved of this judgment by increasing the consumption of colonial wines, and the number of agencies for Australian and Cape wines which have been recently established in this country, show that there is a growing demand for the comparatively rich and generous wines of our colonies. In the cellars referred to it was somewhat amusing to notice that there appeared to have been much less difficulty in producing wine than in manufacturing suitable casks to put it in. The casks containing the wine were of the most motley description Many of them were old French brandy casks, and others had contained whisky, port, and other wines The original inscribed names and marks had in some instances been removed, but in others these names had been smeared over with paint or colouring and still remained as witnesses of the difficulties the Australian viticulturists experience in getting casks suitable for their requirements. From inquiries made on this subject, it appears that the trees of Australia are, from their resinous or other characteristics, unsuitable for cask making, and that, therefore, the proper wood has to be imported. But this difficulty has been overcome in other countries, and it must be met by our colonists if they intend to stand in well European markets. Old casks are always looked upon with suspicion, and those which have contained whisky, port wine, and other highly-flavoured liquids, are quite unsuited for the purpose. The casks used for storing British beer, French and Spanish wines, are not made of native-grown timber, consequently our colonial viticulturists do not labour under inconveniences which are singular but common to them

and their competitors. No doubt the rapid growth of the wine industry has been a hindrance to getting suitable casks for storing the wine made, but in time this difficulty will be overcome, and the supply will eventually overtake the demand. The casks which contained the wine sent from the Cape were very satisfactory. This colony has, however, been a grower of wine for centuries, and time has worked the necessary changes in this direction.

Of the many colonies which sent exhibits, five only can be mentioned as being strictly wine producing countries, viz., New South Wales, South Australia, Victoria, Cape Colony, and Cyprus. West Australia, Queensland, and Canada, are exhibitors of wine, and the latter colony appears to be making great strides in viticulture; but in this industry they cannot be compared with the five before mentioned, the climate or other causes acting prejudicially against them.

The three colonies of New South Wales, South Australia, and Victoria, have made most rapid progress in vine cultivation, and a healthy competition, coupled with energy and determination to succeed, have made this branch of agriculture become one of first importance, and attracted to it men of capital and culture. The industry itself is one of comparatively modern growth. The vine is not indigenous, and it was only introduced into New South Wales from Europe in 1820. In 1831, Mr. Bushby visited Europe, and during his journey collected the most valuable plants he could find in the French and Rhine vineyards. The first settlers being chiefly of English, Scotch, and Irish origin, knew little of the vine and its mode of cultivation; they, therefore, were unacquainted with the fact that to produce good merchantable wine, it was necessary to have proper soil, climate, and suitable vines, and, as a matter of course, their early ventures in wine production ended in failure. Mr. Bushby's knowledge and observation of European methods of wine making gave a fresh impetus to viticulture; but, unfortunately, the vines were planted in warm valleys, the temperature of which approached that of Spain and Portugal, and this had the effect of producing grapes very luscious and rich in saccharine matter, and which yielded wine of high alcoholic quality, and of the sherry and port type. These types of wine had been going out of fashion, and what was worse than the change of fashion, the wines were not properly fermented, and, in course of time, they became sour and unfit for use. Such an unfortunate and disastrous sequel had a most depressing effect upon the viticulturists; many were ruined, others lost heart and withdrew their capital, whilst, in many instances, the vineyards were abandoned and allowed to run to waste. This heavy disaster might have been foreseen, and it was not likely that all engaged in vine cultivation were misled as to the true cause of the calamity, or attributed it solely to unsuitable land and climate. From observation of all the facts which led to the disaster, and a knowledge of what description of wine fashion demanded, some were led to plant suitable vines in higher altitudes, and the results they obtained were not only pecuniarily satisfactory to themselves, but removed the prejudice which had set in against home grown wine. The wines produced of hock, claret, and burgundy type were appreciated, and it was seen that previous calamities were due to ignorance and want of care rather than to climatic influences. These light fully fermented wines which possessed character, flavour, and bouquet soon rose in the estimation of the public, and they became more fully appreciated from two incidents that occurred in 1881. In that year Exhibitions were held at Melbourne and Adelaide. At the former a grand prize of the value of £800 was offered by the Emperor of Germany for award "to an exhibitor in one of the Australian Colonies, as an acknowledgment of the efforts in promoting art and industry, as shown by the high qualities of the goods manufactured by such exhibitor," and at the latter the Mayor of Adelaide offered a handsome piece of plate "to the exhibitor who shall by his exhibit show that he has done most to promote an industry of national importance, and likely to be a source of wealth to the Australian Colonies." To the surprise of many, and to the intense satisfaction of the viticulturists, the Melbourne prize was awarded to Messrs. De Castella and Rowan, St. Hubert's vineyard, and the Adelaide one to Mr. Thomas Hardy, Bankside vineyard, Adelaide. The impetus thus given to the wine industry of Australia still continues. Wines of excellent quality are produced and sold at remunerative prices, and they are becoming known throughout Europe. Three years ago, at the Bordeaux Exhibition, no less than seventy Australian wine growers were exhibitors, and some of the wines were awarded prizes for excellence of quality. Such success at home and abroad has naturally raised the spirits of the vignerons, but fortunately their satisfaction has directed them into the safe channel of further improvement in wine production. By care and diligence at home, extensive reading, and occasional travel to Europe they seem to have diminished the distance between them and European wine growers, and made themselves a part of the European viticulturists, possessing the same aims, and intending by the power of capital and constant application to their business to command a full proportion of the wine trade of Europe.

In the colony of Victoria the quantity of land under vine cultivation in 1884-5 was 9,042 acres, the quantity of wine produced 760,752 gallons, and brandy 3,623 gallons. In New South Wales in 1883 the land planted with vines was 4,378 acres, the quantity of wine produced 589,604 gallons, brandy 4,162 gallons, and grapes for the table 1,378 tons. In South Australia in 1884 the acreage of the vine was 4,590, and the yield 473,535 gallons of wine. These figures give an inadequate idea of what is being done in the colonies named at the present time. The acreage under vines is extending at the rate of not less than 1,000 acres a year in each colony, and as the vineyards have to

be planted some years before they produce wine, it is apparent that the above figures considerably underestimate the capabilities of the vineyards now under cultivation.

(To be continued).

FOODSTUFFS OF MADAGASCAR.

Though supplies of animal food abound in Madagascar, African humped cattle, goats, fat-tailed sheep, pigs, and poultry having long been naturalised, these are chiefly reared for export, and, except at festival time, the people as a mass, consume but little meat, save fish and freshwater crustaceans. They collect much honey for the preparation of an intoxicating drink.

Rice, in several varieties, may be denominated the staff of life to the Malagasy, most of their time being occupied in its cultivation. The seed is sown in nurseries (*ketsa*) formed on the margins of rivers, or in hollows of the hills, in a series of terraces, to which water is conducted with much skill for irrigation purposes, especially by the Betsileo tribes. Tillage is effected by a long-handled spade, the plough being unknown. Before transplanting the young rice to its permanent ground, the muddy soil is trodden by cattle. In the Tanala country this practice is modified: instead of planting in regular fields, and irrigating these, the natives cut down brushwood on the hillside, burn it on the ground before the rainy season sets in, and sow their rice on this, never occupying the same spot two years in succession. The threshing of the rice is effected by beating it in bundles on stones set upright on a threshing floor. The grain is stored either in pits dug in hard red clay (the Hova custom), or in small wooden barns raised above the reach of vermin (in the coast districts). Husking is performed by women with the aid of a wooden mortar.

Other vegetable foodstuffs comprise manioc root (*mangahazo*), consumed in large quantities; a kind of arrowroot obtained from the root of *Tacca pinnatifida*, a staple article of diet in the west; sugar cane and coffee, both of good quality, and promising well for the future of commercial agriculture; maize, millet, yams, sweet potatoes, and various tropical fruits in general cultivation; the esculent root of the water plant called lace-leaf (*Ouvirandra fenestralis*); and the edible fruit of the *nonok* (*Ficus* [*Urostigma*] *melleri*); while a pure, cool drink is drawn from the traveller's tree (*Urania speciosa*).

General Notes.

INDUSTRIAL MUSEUMS OF FOREIGN GOODS.—The Wolverhampton Chamber of Commerce have sent a letter to Lord Iddesleigh informing him of the proposal to establish an industrial museum to enable manufacturers and artisans of the district to understand better the exact nature of the competition with which they have to contend in foreign and colonial markets. His lordship is requested to instruct her Majesty's Consul at Madrid to transmit to the chamber a collection of the locks in common use in Spain, otherwise than those of English make, and, as far as practicable, to give the prices the samples can be obtained at from the makers. If the Government cannot properly undertake the cost of obtaining the samples the chamber will defray it. The Secretary for Foreign Affairs has acceded to this request.

MANCHESTER EXHIBITION, 1877.—At the Royal Jubilee Exhibition, Manchester, to be held in 1887, there will be a sub-section of silk industry, and Mr. Thomas Wardle is the chairman of the committee appointed to carry out the scheme. The objects proposed to be exhibited will include collections of the eggs, living larvæ, and moths of a considerable number of species of silkworms, both domesticated, semi-domesticated, and wild. Examples of the various races or breeds of the cocoons from which are obtained the ordinary silks of commerce from France, Italy, the whole of the English Colonies, and India, China, Japan, Bokhara, Persia, Siam, &c. Examples of silk reeled from these cocoons, showing both native and European reeling. Examples of the best methods of cocoon reeling in operation, as practised in Europe, as well as models of reeling machines from countries outside Europe, showing the reeling of the silks of commerce, and also of wild silks. Typical specimens of the silk fabrics of all countries, both in the dyed and undyed states. These would include, among others, the plushes, seal cloths, rugs, carpets, &c., produced in Yorkshire from waste or spun silk; figured silk, satins, and velvets in plain colours and embossed, or in woven patterns; foulards, crêpes, tulle, black and coloured faille and gros-grain for dress stuffs, moiré antique; serges, mixed stuffs, silks for parasols and umbrellas, taffetas and poplins in plain colours and blacks, silks for church ornament, and all kinds of domestic upholstery, and for carriages; printed silks, Indian silks and embroideries, examples of Indian skein-dyeing and piece-dyeing; tapestries, ribbons, handkerchiefs, cravats, grenadines, ferrets, bindings, braids, elastic webs, tassels, fringes, cordonnet; silk lace from Malta, Nottingham, Calais, &c., and a collection of the silk fabrics of India, Burmah, and Singapore. It is proposed to have one or more silk looms in operation, and Indian artisans at work weaving, dyeing, and printing.

ADELAIDE EXHIBITION.—Advices have been received from Adelaide to the effect that the detailed plans of the Exhibition Buildings will arrive in London on Monday, 6th inst. It has been decided that the allotment of space shall take place immediately after the arrival of the plans. A notice has been issued requesting intending exhibitors to send in their applications before the 7th inst., to avoid finding that the best sites have already been occupied.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

DECEMBER 8.—"Glow Lamps, their Use and Manufacture." By MAJOR-GENERAL C. E. WEBBER, R.E., C.B.

DECEMBER 15.—Adjourned Discussion on Dr. C. MEYMOTT TIDY's paper on "Treatment of Sewage."

At the meetings after Christmas the following papers (among others) will be read :—

"Cameo Cutting as an Occupation." By J. B. MARSH.

"Miners' Safety Lamps." By EDWARD H. LIVEING.

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Photographic Lenses." By J. TRAILL TAYLOR.

"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Irish Industries." By REV. CANON BAGOT.

"Adulteration of Beer." By A. GORDON SALAMON.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

"Railway Brakes." By WILLIAM P. MARSHALL.

"Electric Locomotion." By A. RECKENZAUN.

"The Living Organisms of the Air: the Effect of Place and Climate on their prevalence." By DR. PERCY FRANKLAND.

CANTOR LECTURES.

The First Course will be on "Principles and Practice of Ornamental Design." By LEWIS FOREMAN DAY. Four Lectures.

LECTURE II.—DECEMBER 6.—*The Distributiou of Ornamental Design.*—The ways in which a given surface may be attacked and occupied. The treatment of irregular and awkward spaces. The relation of detail to the order of its distribution.

LECTURE III.—DECEMBER 13.—*The Fitness of Ornamental Form.*—The adaptation of ornamental form to considerations of use and workmanlikeness. Style and ornament evolved out of the characteristic handling of the tool. Where to stop.

LECTURE IV.—DECEMBER 20.—*Natural Form and Ornamental Treatment.*—Artificiality and literalism. Mistaken convention. Precedent. The help and the hindrance of nature. The persuasion of natural forms to ornamental purpose. Accident and design.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 6..SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "The Principle and Practice of Ornamental Design." (Lecture II.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. Discussion on "The Position of the Tenant Farmer," to be opened by Mr. C. S. Read.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. G. B. Jerram, "River Pollution caused by Sewage Disposal."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. E. H. Traschel, "Strontium Hydrate." 2. Mr. T. Fairly, "Various Forms of Filter Pumps and Water Jet Aspirators."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Mr. E. Ryde, "The Tithe Question, with Suggestions for the Redemption of the Rent-Charge." 2. Discussion on Mr. J. W. Willis-Bund's paper, "Extraordinary Tithe and the Redemption Act of 1886."

British Architects, 9, Conduit-street, W., 8 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. S. D. Peet, "Worship and Traditions of the Aborigines of North America."

TUESDAY, DEC. 7...Metropolitan Provident Medical Association (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m.

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Annual General Meeting.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Dr. John Hopkinson, "The Electric Lighthouses of Macquarie and of Tino."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. Frank E. Beddard, "Observations on the Development and Structure of the Ovum in the Dipnoi." 2. Mr. A. Smith-Woodward, "The Anatomy and Systematic Position of the Liassic Selachian, *Squaloraja polyspondyla*." 3. Mr. J. Bland Sutton, "Atavism: a Critical and Analytical Study."

Colonial Institute, Prince's-hall, Piccadilly, W., 8 p.m. Dr. George Watt, C.I.E. "The Trade of India, and its Further Development."

WEDNESDAY, DEC. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Major-General C. E. Webber, R.E., C.B., "Glow-lamps, their Use and Manufacture."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

THURSDAY, DEC. 9..Antiquaries, Burlington-house, W., 8½ p.m.

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

FRIDAY, DEC. 10...Commons Preservation Society (at the HOUSE OF THE SOCIETY OF ARTS), 4 p.m.

Society for Promoting Industrial Villages (at the HOUSE OF THE SOCIETY OF ARTS). 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, DEC. 11...Æronauticul Society (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m.

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. W. Ramsay and Dr. Sidney Young, "The Influence of Condition from the Liquid to the Solid State on Vapour Pressure;" and "The Nature of Liquids as shown by a study of the Thermal Properties of Stable and Dissociable Bodies." 2. Mr. James Walker, "Cauchy's Theory of Reflection and Refraction."

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FRIDAY, DECEMBER 10, 1886.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COLONIAL AND INDIAN EXHIBITION.

With the present number of the *Journal* is issued as a Supplement, a copy of the Diploma of the Colonial and Indian Exhibition. A description of the Diploma will be found on page 69.

Any member of the Society can have an extra unfolded copy of the plate on application to the Secretary.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Thursday, 2nd inst., at 4.15 p.m. Present:—Sir George Birdwood, M.D., LL.D., C.S.I., in the chair; Mr. Hyde Clarke, Major-Gen. Sir Frederic J. Goldsmid, K.C.S.I., C.B., and Mr. J. T. Wood, with Mr. H. Trueman Wood, Secretary of the Society, and Mr. Demetrius Boulger, Secretary of the Section. The programme of papers to be read during the present Session was discussed.

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of this Section was held on Monday, 6th inst., at 4.30 p.m. Present:—Sir Saul Samuel, K.C.M.G., in the chair; Sir Francis Dillon Bell, K.C.M.G., C.B., Lord Alfred S. Churchill, Mr. Hyde Clarke, Mr. B. Francis Cobb, Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of Council, Lieut.-Col. A. C. Hamilton, R.E., Sir Villiers Lister, K.C.M.G., Mr. Trelawney Saunders, and Mr. P. L. Simmonds, with Mr. H. Trueman Wood, Secretary of the Society, and Mr. Edward Cunliffe-Owen, C.M.G., Secretary of the Section. The programme of papers for the present Session was discussed.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 5th and 12th, 1887, by Professor A. W. Reinold, F.R.S., on "Soap Bubbles." The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

The second lecture of the course on the "Principles and Practice of Ornamental Design," was delivered by Mr. Lewis Foreman Day, on Monday evening, 6th inst. The special subject was the distribution of ornamental design, in respect to which the lecturer referred to the ways in which a surface may be occupied, the treatment of irregular and awkward spaces, the relation of detail, and the order of its distribution.

The Lectures will be printed in the *Journal* during the Christmas recess.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 8, 1886; Professor W. G. Adams, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barber-Starkey, William Joseph Starkey, Aldenham-park, Bridgnorth, Salop.
Hadfield, Robert Abbott, Hadfield's Steel Foundry Company, Newhall-road, Attercliffe, Sheffield.
Hassall, William, Beach-villa, Meadow-road, Beeston, Notts.

Lewis, Herbert Henry Leech, Cambridge Works, Cambridge-heath-road, E.
Molyneux, Patrick, Atlantic Wharf, Bow-common, E.
Stopford, W. H., 16, Clifton-road, Halifax.

The following candidates were balloted for and duly elected members of the Society.

Bailey, Thomas Jerram, Riga-villa, The Grove, Clapham-road, S.W.
Currie, John, Rowan Tree-bank, Alexandria, Scotland.
Dennis, Nelson F., 67, South-street, Southampton-street, Peckham, S.E.
Gresham, James, Craven Iron Works, Ordsall-lane, Manchester.
Rhodes, Henry Douglas, St. Stephen's Club, Westminster, S.W.
Smith, Michael Holroyd, Royal Insurance-buildings, Crossley-street, Halifax.
Turner, Eustace H., 43, St. Paul's-road, Highbury, N.
Wootton, Henry, Ambleside, Kew Gardens-road, Kew.
Zaehnsdorf, J. W., 36 Catherine-street, W.C.

The paper read was—

GLOW - LAMPS, THEIR USE AND MANUFACTURE.

By Major-General C. E. Webber, R.E., C.B.

It is not my intention to enter into any dissertation on the various kinds of glow or incandescence lamps which have appeared from time to time since their first use by De Moleyns, Starr and King, between 1840 and 1850, nor do I wish to trouble my audience with the history of the inventions which have led up to the so-called glow-lamp now in commercial use.

The words "incandescent" or "incandescence" are, like all other adjectives of four syllables, cumbersome, and the word "glow" has been adopted by many, and is for our purposes sufficiently expressive to identify a means of domestic illumination now almost as familiar to the public eye as the gas jet. From the point of view whence I beg my audience will regard the subject, it is my desire to lead them to realise that in the manufacture of glow-lamps we have a rapidly growing industry, in the increase and efficiency of which they may all before long be interested. And I shall only remind them of the antagonisms of rival inventors, and the struggles for precedence arising out of the same, when that part of the question is necessary to my subject.

It is true that the time has not yet arrived when a general audience can be expected to evince as much interest in my subject as they would naturally do in the lectures on candles or lamp, delivered in this hall, but it is believed that a more general knowledge of this very interesting subject will aid in its popularisation, and will bring home to many who have not yet accepted the fact, that illumination by electricity for home purposes is a reality, and that this little bulb, containing a filament which becomes incandescent by the passage of a current of electricity, has made possible and practical a system of illumination which we who use it would gladly convince everyone is superior, from a sanitary and economical point of view, to any other known means.

A great deal too much that is unreasonable has been said here and elsewhere as to these advantages. Allow me for a short space to draw attention to some points connected therewith. When the glow-lamp was first introduced, its promoters misled the public judgment and eye by claiming for it more duty than it was able to perform. It was shown in exhibitions, where each exhibitor vied with the other in one direction, namely, in creating a blaze of light, where the little glow-lamp was placed alongside the powerful and intense brilliancy of the arc electric light. The exhibition of lamps of 16 to 20 candle-power in groups became the custom, and the public was unconsciously led to compare these, in their minds, with gas jets and Argand burners of far lower real candle-power. When they went further in their inquiries, with the view to practical adoption, they were immediately met by the inequality of cost, which, although in the first instance due to the outlay in plant for supplying electricity, is heavily weighted with a factor arising out of this want of consideration of the relative candle-power of the lamps and other means of lighting.

Born and educated in the use of illuminants which present to the eye a soft wide gaseous flame, having a measurable iridescent surface containing incandescent particles widely dispersed, we were quite unprepared to estimate the increased power of the brilliant little line of intense incandescence that meets our view when we regard this glow-lamp.

Those with eyes able to bear its penetrating effects hailed it as a means of increasing light, regardless of the extravagance in using more than they actually required; and those with sensitive retina only submitted to it as preferable to the overpowering glare of the arc.

From its use in exhibitions, and with the traditions of the gas-fitter, electric light crept

into our places of public resort, and thence into our dwelling-rooms.

Wherever one went, either the gas-fittings were made the supports of the glow-lamp or the lamps were hung from the ceiling, so that on entering a room lighted by a number of these pendants, a brilliant line of light cut the eyes like the blow of a whip lash, rendering everything for a time obscure. Indeed, from careful study of places lighted with the glow-lamp, I have come to the conclusion that the eye is much longer recovering the effects of this sudden slight paralysis of its light receptive powers than is supposed; and that this cry of more light which one hears, where the subject has been dealt with from a gas-fitter's point of view, is simply due to temporary obscuration and loss of power to discover the true needs for illumination of the surrounding objects.

In more than one club in London, where the lines I have referred to have been followed in applying electric light, although the candle-power of the latter is about three times the value of that of the lamps previously in use, there is a constant outcry from the young eyes that "there is not enough light," and from the old eyes that "they know not where to go to avoid the glare."

Of the remedies suggested for this, I cannot subscribe to one which has emanated from a well-known architect which has come to my notice, namely, that as the position of the sun, our illuminant by day, is overhead and high up out of the ordinary direction of vision, so we ought to make use of electric lights by placing them high up in our rooms, and increase their power and number in order to make up for the loss of light due to distance. Hence the introduction of glow-lamps into the ornaments of the frieze at a well-known restaurant, and their substitution for gas jets, lamps, and candles, in chandeliers and sunlights.

When regarding this question from the point of view of economy, we see the reason why the cost of electric lighting has so much deterred its use in competition with cheap gas, while at the same time the still cheaper arc electric light is ignored or condemned.

The screening of glow-lamps from direct vision, adds still further to the cost of lighting, but if arc lamps were more used, their cheapness would allow of much light being wasted in concealing their brilliancy, by deriving the light only from reflecting surfaces.

The efficiency of arc lamps is now so well secured, that the old objections to them should fast disappear. That concerning the so-called ghastliness of the light has been completely dispelled by the experiments of Captain Abney and others on the subject of the colour of the electric light.

The conclusion I have come to, after visiting electric light installations at home and in many parts of the Continent, is that with all kinds of electric lamps used in interiors, the eye ought never to be allowed to meet the source of light, even when subdued 30 per cent. by transmission through obscuring media. That arc lamps should be employed in all large spaces placed well overhead, and as much as possible so that their rays shall meet the eye of the uplooker by reflection only. That glow-lamps should be invariably shaded from the eye, and so placed as to be as near as possible to the object to be seen, for instance, on brackets attached to the frames of pictures, with opaque reflectors. For dining tables with white table cloths, well concealed in nearly opaque shades. For reading or writing, small candle-power lamps are ample, and least injurious to the eye, if concealed in opaque shades suspended from curved table stands about twelve inches from the paper. For general illumination of rooms, the shades may be more or less semi-opaque, but the reflectors or diffusers should be as brilliant as possible.

Lately, the Council of the Royal Albert Hall has been making a few experiments in the distribution of light within that noble building. Both arc and glow-lamps have been tried, the former in the upper, the latter in the lower part of the hall. With the arcs, it was found that only in the upper arcade could they be concealed from the eyes of the audience. The effect of brilliantly lighting up the hall with twelve 2,000 candle-power arcs was good, but the light reflected into the body of the hall by the back wall was probably only one-tenth of that yielded. Six more such lamps placed high up in the lantern were of no more use than moonlight would have been, but when lowered below the level of the cornice, gave, directly or by reflection, their full effect. When all the eighteen were suspended in a group and let well down into the body of the hall, the illuminating effect on objects was inferior to that of the thirty-two gas pendants, each with sixty gas jets, which are suspended all round the hall just above the arcade, but when one turned the back to the light, the same print was equally easily deciphered with each illuminant.

What the effect of diffusing the light of such a group would have been if the lamps had been confined in an obscured glass lantern, remains to be proved. Advocates of concentration and of dispersion of the arc lamps were found. But when it came to the concentration or dispersion of the glow-lamps used in the trial, there was little difference of opinion as to the good effect of throwing the light from them towards the backs of the boxes, by placing them under the ceilings of each box, and concealing them from the eye of the audience. Some will recall the gloomy cavernous effect of the three tiers of boxes at the Royal Albert Hall. Lighted up, as some of them were for the trial I am describing, the scene was pronounced fairy-like.

The lights were placed so as to be of no inconvenience to the occupants; but the effect was to lighten the whole aspect of the elevation, and as every lamp was concealed, the eye could dwell on features of construction and colour which before were no more than masses of shade.

This concealment of the glow-lamps was also carried out on the orchestra stage, under the organ, where the trial was equally successful in demonstrating the fact that, although the loss of light may be considerable by following such a course, that loss is a gain, when it can be proved (of which there is no doubt) that the eye is far better able to examine the objects around the concealed lights than if they were exposed.

It is curious how in theatres this theory of the advantage of concealment of light is carried out on one side of the house and not on another. At Buda Pesth I saw this well exemplified, where a large theatre has been lately lighted by electricity. Above the stage, and concealed amongst the suspended scenery, were seven treble rows of twenty glow-lamps, arranged so as to be altered, raised, and lowered, in various ways, but, alike with the footlights, not one could be seen by the audience. Whilst in the auditorium itself the gas-fitter again resumed his sway, and between chandeliers and brackets, on the fronts of the boxes and galleries, the lights were successfully placed, so that the dazzled eye could not dwell for a moment on the beauties, either physical or decorative, of a very beautiful building, crowded with an audience which came as much to be seen as to see.

A very simple example will enable you to realise what most who have thought of these matters well understand, namely, the entirely different conditions which are being dealt with in using candles, lamps, or electric glow-lamps. [An example was here shown of (1) a group of ten candles; (2) a gas jet; (3) a paraffin lamp; (4) a glow lamp.]

Photometrically each of these yield light of the value of about ten candles; but how different is the impression on the eye. Does it not show that these must be dealt with and employed differently in their use for illuminating our hours of darkness and to meet our various wants. Because artists love and seize on the effects of highly contrasting light and shade to perpetuate striking scenes, there is no reason why we should live under such conditions. Though a beautifully dressed woman may appear to great advantage for a minute under a brilliant flood of light, she would, I think, sacrifice the full effect of her splendour rather than remain long under its influence.

One might go on for ever with examples of this kind. The real cause of so much difference of opinion on the question probably lies in the varying conditions of the human eye, in respect to its sensitiveness of light, and its power to recoil from its effects before temporary injuiy has been done to it.

From the manufacturing point of view, the glow-lamp consists of three distinct parts, namely:—The filament; the wire mount or conductor; and the glass bulb.

The amount of research and experiment which has led to the perfection which now we may safely say exists in these three has been very large.

It would be invidious to particularise individual labours, and the list would be too long to occupy the time of the present meeting. The burner, or bridge, has been the subject of a large part of these labours. The conditions which it should fulfil are various, and a good filament for the purpose has been produced from various materials.

But the object of most inventors has been to find a highly refractory substance, and they have all ended in using carbon of either a fibrous or amorphous consistency, which they produce in the shape and of the nature which they require, by various processes.

The conditions of form, density, uniformity of section, surface and electrical resistance, with which a glow-lamp bridge must be endowed are now well understood.

First, the form has been governed by the need to hold within a bulb of a given size a carbon wire of a given length. The simplest

example of the means resorted to, to achieve this, is shown in this lamp, in which it will be seen that by giving the filament a coil, one of about seven inches in length is contained in a bulb only three inches in length, without unduly approaching the glass.

Another condition of form is that of uniformity of section. With some of the raw materials used, it is almost impossible to obtain this in the early preparation without gauging them in a die, by means of which the irregularities of surface are scraped off before the thread or strip is bent into form previous to baking.

This is the case with the material of the Edison filament, of the preparations of which, from especially selected bamboo in all its stages, we have seen beautiful examples at the Paris and Crystal Palace Electric Exhibitions. It is not the case with the filaments prepared by squirting a viscous solution of cellulose into a precipitating solution, a process which produces at once the most perfect uniformity of section, such as that used for making the filaments, for instance, of the Victoria Brush glow-lamp.

It will be at once understood that the after stage of deposing carbon by the process discovered by Depretz is not essential to the obtaining of such uniformity in the latter case as it is in that of other inventors, who carve it out of raw vegetable material of either a fibrous nature or out of strips of paper or parchment. Most of these raw materials are by way of being trade secrets; indeed, in the case of one glow-lamp maker on the Continent, I know that the inventor has never divulged his secret, and that he prepares the raw material in the privacy of home, and brings it to the works in such a form as almost to defy detection of its origin.

The raw material is generally wound on to blocks of carbon, and then baked at high temperatures. Here, again, we have a stage in the preparation of filaments which has given rise to a great deal of labour and research. The reasons for the varying results obtained from bakings were at first very obscure. With some kind of materials, filaments off the same blocks, and off different blocks, showed differences of contraction, causing fracture in the process, differences of tensile strength, and of surface, for which it was difficult to account.

Various means were adopted to regulate the rate of increase and decrease of the temperature in the oven, to exclude oxygen from contact with the baking, and the results as often misled the engineer as they helped to bring him to the desired standard process. All who have been through this will bear witness to how often they were disappointed, and how only by slow, steady, and patient investigations and collaborations of results, they at length were able to deduce the conclusions which have led them to the true path which must be followed, in the preparation and process of baking of the raw material, from which they have seen no reason since to depart. To produce a carbon more or less dense and uniform has been the object of all, but if I have been understood, it is obvious that I attach the most importance to that process by which sufficient density and uniformity of section and surface is actually reached at this stage of the preparations of the filament.

We now have to study a stage which may be regarded as the most important with reference to the commercial use of the glow-lamp. So early as 1878 it was discovered, or revealed, that in order to be able to use a large number of glow-lamps on one system, they must all be subject to the same electrical conditions of tension. It was found that it would be impossible to maintain uniform illumination in all the glow-lamps on a system, if each lamp was to be subject to different conditions of pressure; and that the only way to achieve a practical result was to connect one terminal of all the lamps to a main conductor conveying a current in the first place sufficient for all the lamps destined to be used in the system, and in the second place having an E.M.F. or potential above zero (zero being an empirical "earth)," of an energy suitable to bring the filament to a state of incandescence; and so arrange that the value of the E.M.F. should be the same throughout.

In other words, the system of distribution known as the "parallel" system was thus practically discovered. The second or return conducting path is, of course, necessary when dealing with a physical development of energy such as what we call "electricity," to complete the circuit to the so-called negative terminal of the dynamo, or other source.

It will readily be appreciated that the word "parallel" is a misnomer, the parallelism of the conductors having nothing to do with efficiency. And that their being carried alongside of one another throughout a building only arises out of a desire to economise the labour of the workmen who have to put them up.

It would, I conceive, be well if the public,

and above all the insurance companies (for it is largely a question of fire risk), could be brought to understand that the second or return wire is electrically the same as the "earth" of the electrician, and that so long as the positive, or supply wire, is well insulated and kept far apart from the negative, or return wire, no further precautions are necessary; and when they are thus far apart, even if one is bare, greater security is obtained than by the present system, which unreasoningly insulates the wire which need not be in a state of electrical tension, as well as that which is always ready to discharge. I have digressed a little way to show why absolute uniformity in the glow-lamps is necessary to such a system; nothing in its condition could be made to compensate for any defect in that respect. The chief aim, then, must be to secure this uniformity in the manufacture of the filaments of glow-lamps.

In a good glow-lamp, inseparable from uniformity of resistance, are uniformity of surface and incandescence.

Uniformity of resistance when hot, means that each lamp will (so to speak) consume the same amount of current, and this can only be secured by electrical measurement under the conditions of uniform electrical pressure.

Uniformity of incandescence and surface means that lamps possessing these qualities give almost the same candle-power, and this can only be obtained in the manufacturing processes by visual measurement.

To secure all three, it is necessary to combine a means of visual and electrical measurement. The former is but approximate, the latter is as accurate as a Thomson's galvanometer can make it. In either case, however, when large numbers of filaments have to be standardised, neither measurement can be expected to produce greater accuracy than is essentially necessary for a good commercial lamp; and the fact is, that while uniformity of E.M.F. is the condition which must not be departed from, no harm arises in practice if the current consumed and the candle-power is not absolutely uniform.

Thus, the required resistance of each lamp is, such a resistance as will, under the condition of uniform E.M.F. or electrical pressure, give, with a small varying area of surface, such a candle-power as that to the eye all the lamps are alike when they are incandesced.

This required resistance is obtained in the following way by a process known in the electrical world as "flashing," a title which, I believe I am right in stating, owes its origin to Mr. Lane Fox:—

The baked filament is placed in these tongs and lowered into a glass chamber full of hydrocarbon gas. An electric current is passed through it, which raises it to a high temperature, and the carbon in the gas attaches itself to, or is deposed on, the heated surface. The use of this beautiful phenomenon is not essential, but is a very ready and simple means for rapidly increasing the size of the filament, and necessarily in consequence for reducing its electrical resistance.

While this is being done, the operator is being guided by the two means of measurement already mentioned, so as to know when he has reached the required standard, by reducing the resistance to that point, under a uniform electrical pressure (now generally expressed as "with a uniform voltage"), at which the state of incandescence is reached which yields light of the candle-power required in the lamps under manufacture.

The process, as you see before you, is one which is most conveniently carried out intermittently and cautiously, as, inseparable from it, just as the thickness of the filament is increased, so the resistance diminishes, and more current is required to give the high temperature which attracts the carbon from the surrounding gas.

There is not much to be said about the platinum mount. There are small details in its construction, and the manner of preventing its two sides coming into contact, which vary little in design, and all have the common object. You now see this done by the introduction of the little glass bridge piece. The platinum which should be used, its homogeneity and physical conditions, are all objects of experiment and great care, too minute with them to trouble this audience.

The filaments having been thus standardised, they have to be mounted or attached to the metal conductors, which pass through the glass by which their ends are electrically in communication with the outer air.

An important condition of the result of any process of doing this must obviously be the obtaining of a good and perfect electrical contact or joint between the metal and the carbon. The absence of this would be fatal to the future of the lamp. Every inventor has laboured hard to secure this.

The making of good joints between the ends of electric conductors has been, for the last thirty years, the subject of intense care to every

engineer who deals with electricity. No wonder that its importance should be vital in the case of these two little connections, knowing that once sealed up in this bulb they cannot be got at again for repairs, and also knowing the intensity of the current to which they must be the path. In joining iron or copper wires to one another, telegraph engineers long ago knew the difference in the resistance of their lines due to the careful use of soldered joints, instead of leaving them what they call "dry."

Various forms of joints have been devised, so that the tensile connections between the wires, and the surfaces in contact exposed to the deposition of solder, should be sufficient to neutralise all resistance.

The efficiency of such devices became more important when the joints for the purpose under consideration had to be designed, because of the necessity, not only to neutralise resistance at these points in the circuit, but also to reduce it at this point in comparison to that of the carbon. Although this desideratum is ardently sought, in practice it is difficult to prevent heating at the joint when the current exceeds 1·4 of an ampère. Hence many very ingenious little contrivances, but all having the same object.

Next is the question of the solder or cement to be used, and I believe that no one will dispute that Mr. Lane Fox was the first to use the process of deposition of carbon by electrically heating the joint in a vessel containing an hydrocarbon surrounding, so as to solder the metal and carbon surfaces to one another. The way in which this is effected is pretty much the same in execution everywhere.

The wire mount of platinum wire, or other suitable metallic conductor, is placed in contact with the carbon filament or bridge, so that they are kept together by any suitable contrivance of their ends, and the joint is then flashed.

As any further deposition of carbon on the filament itself would alter the standard effected in the previous stage of the process of carbonisation, it will not answer to allow any current to pass through it. This is prevented by any simple means of short circuiting the current, so that it shall only pass through the joint. In the process carried out before you, this is done by this apparatus, which holds the filament in this vessel, which contains hydrocarbon in a liquid instead of in the gaseous form you saw used for carbonisation in the previous stage.

Practically, the chemical phenomena are identical in each case, and the result in this one is a perfectly homogeneous electrical joint, larger in section than the other portions of the path of the current, and therefore of ample strength and conductivity to prevent risk of any future wear and tear through high temperature and rough usage.

Having completed this important factor in the construction of a glow-lamp, let us turn to the envelope, or bulb, which is destined to be the home of the burner, under conditions for supporting combustion opposite to those under which any other means of illumination will act.

In the latter, the presence of oxygen in due proportion to the supply of hydrocarbon and other light-yielding gases is vital to its usefulness.

In the former, the presence of oxygen within the bulb, and its contact with the carbon bridge, is rapid death, instead of the slow decay, ending in extinction, which is the best that as yet can be expected from the glow-lamp.

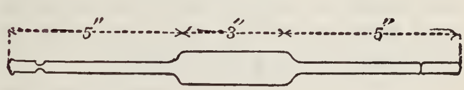
Imperfect though it may be, it is, however, very good, and not likely to be superseded.

This little glass vessel has also its stages of manufacture, as you will see by the performance in your presence, the power of demonstrating which, together with the processes previously shown, I owe to the permission of the Board of the Anglo-American Brush Electric Light Corporation, whose factory and offices are situated on the Surrey side of the Thames, just over against Charing-cross.

You see that a glass tube of about three-quarters of an inch interior diameter is the fioundation.

The first stage you see is to produce an object like this:—

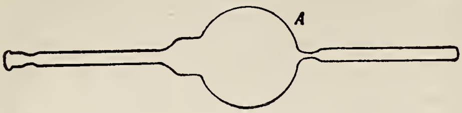
Fig. 1.



by drawing out the glass into a small tube of about five inches long, at each end of a section of the original tube about three inches long.

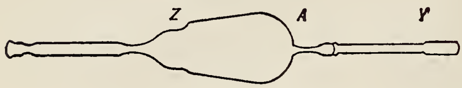
Next the small tube is slightly contracted at (A), when the thick part is heated and blown to this shape—

Fig. 2.



Under a second heating, with the object of completing the form of the bulb, it is brought to the following form—

Fig. 3.



A Y is then cut off, and another tube of uniform section joined on in its place. This passage is afterwards used for exhausting. The bulb is now ready for the introduction of the filament, which has been prepared and mounted in the way you have seen. Z is warmed, the end taken off, and it is pressed into an elliptical shape.

The filament is introduced, and under the influence of heat the glass is pressed around the platinum leads, and the little loops at their ends only are left projecting. The lamp is now ready for the last part of the manufacturing stage, in which a vacuum within the bulb is produced.

The last stage, namely, the exhaustion, is probably that upon which the life of the lamp most largely depends. This process, exemplified by the action of the mercury pump which you see here, is apparently a very simple one, and would be so, were it not that there are several small impediments to success which, when one comes to demanding a vacuum of one millionth of an atmosphere, are very serious difficulties.

In the first place, great attention must be paid to the construction of every part of the pump, for, with valves or taps of the ordinary kind, inevitable failure and waste of labour would ensue by leakage when the stage of high vacuum is being approached.

I will avoid going into any description of the merits of the various forms of mercurial air pumps, because Professor Sylvanus Thompson will before long read a paper on that subject before this Society; so I will pass on to some of the conditions of their use for exhausting glow-lamps.

It was found that the attempt to obtain such a vacuum as is required in the industry I have ventured to bring to your notice to-night, has to encounter the presence of moisture in the air, and the presence of air in the glass, in the platinum, and in the carbon. Besides, the process of exhaustion is the only vehicle for ridding the filament of what are called the occluded gases.

A part of the moisture can be, and is, removed by absorbent substances placed inside the pumps, but alterations of temperature in the glass and in the filament, brought about by several means, which I cannot show here, are alone found to be really effective, and this application of heat to expel the moisture and air from the parts of the pump open to the lamp must be continued, with exhaustion, at certain stages of the operation, until by a suitable test it is found that the requisite degree of vacuum has been reached.

The best vacuum test is probably that which is made electrically. This is carried out with an induction coil of very high tension, and the test consists in observing when the sparks between two poles of platinum, placed in a part of the pump which shares the vacuum with the lamp under treatment, travels outside the glass instead of inside.

The process of exhaustion in the early days of glow-lamp making occupied three or four hours; now it has, by better appliances, been reduced in time to a little more than half-an-hour. The number of lamps turned out in a factory is determined by the number of lamps on each pump, generally three or four, and the number of pumps. Allowing ten removes a-day and twenty-five pumps, each having four lamps, a manufactory could turn out 1,000 lamps a-day.

The lamps are next tested and classified for candle-power and voltage, and marked accordingly; formerly 50 per cent. failed to give the standard of efficiency in those respects, now all are up to the mark within 10 per cent.

The electrical efficiency of lamps is measured by the watts expended per candle-power. As is well known, economy in this direction effects a saving for a given amount of light required on an installation of electric lighting, in power converted into electricity, and in the size of the conductors which convey it to the lamps.

Most makers' lamps vary between 3 and 5 watts per candle-power, when the lamps are new, under the conditions of voltage which gives the longest life. Those are alleged to be as follows:—Edison, 5 watts; Swan-Edison's, between 3·5 and 4 watts; Victoria, 3·5 watts; Woodhouse-Rawson, 3·0 watts.

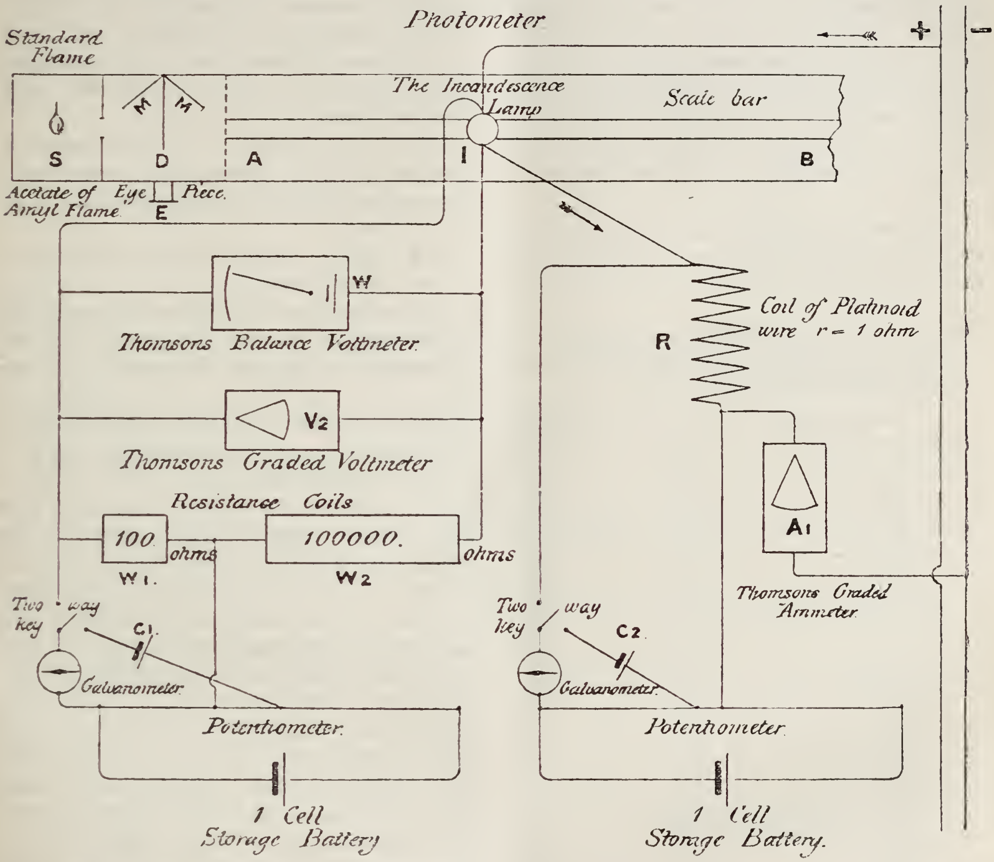
The scientific man does not require to be told what are the tests to which he should subject glow-lamps to prove their efficiency. At the Crystal Palace Exhibition, at Vienna, at the Health Exhibition, and at Philadelphia, very exhaustive tests were applied to the lamps of several well-known makers, but, at the best, all these have proved unsatisfactory, because the makers themselves were not likely to contribute their average lamp, and in some cases either declined to contribute at all, or repudiated the results after they were published.

The tests which require apparatus not usually outside a laboratory are those which observe the E.M.F., the current, the resistance, and the watts per candle-power.

There are various arrangements for testing candle-power. I am indebted to Dr. Fleming for that which is shown on the diagram.

The arrangement is a very special one for

FIG. 4.



securing an accurate E.M.F. in the lamp in process of testing. The disc, D, of a photometer is fixed, instead of, as is usual, being left free to slide. The standard flame at S is a lamp of burning pear-oil, or acetate of amyl, with a flame of regulated height. The lamp, I, to be tested, is placed on a carrier which slides along the scale bar, A B.

First, to test the current. The current which feeds the lamps passes along the mains plus and minus, *viâ* the minus through a Thomson's graded ammeter and a platinoid resistance, R, to one terminal of the lamp. The difference of potential between the termini of the coil is compared with the E.M.F. of a standard Clarke's cell, C_2, on a potentiometer. This latter is a perfect check on the accuracy of the ammeter.

Second, to test the working E.M.F., at the termini of the lamp. Similarly, this is made with a Thompson's balance voltmeter, W, as well as a Thomson's grade voltmeter, V_2, checked by measuring the difference of potential at the extremities of a 100 ohm coil W_1, in series with a 10,000 ohms coil W_2.

The voltmeters themselves are placed

between the terminals of the lamp, but by means of the resistances, the potentiometer with a Clarke's standard cell C_1 is only compared with $\frac{1}{1000}$ths of the E.M.F. of the lamp.

It will be understood that the standard cell in each is the ultimate check on the measuring instruments, provided the resistances are perfectly true, and if the latter do not agree with the former, they have to be re-calibrated.

The need for standardising the measuring instruments used by electricians has been pressed home by Dr. Fleming to the conviction of every one concerned, but up till now little has been done beyond deliberation by a committee of the Society of Telegraph Engineers and Electricians. At present we do not know that we all mean the same thing when we speak of some of these units of measurement.

Users of glow-lamps will be interested in the Table shown, which is an average of some tests of the lamps of two or three makers:—

Mean current and candle-power of two long-lived 100 *volt* 17*-c.p. lamps of different makers, run at* 100 *volts, and tested every* 100 *hours.*

Initial current		=	·63 *a*	C.P. =	18·5*
After 100 hours	,,	,,	·65 *a*	,, ,,	18·8
,, 200 ,,	,,	,,	·65 *a*	,, ,,	20·7
,, 300 ,,	,,	,,	·65 *a*	,, ,,	18·5
,, 400 ,,	,,	,,	·65 *a*	,, ,,	18·5
,, 500 ,,	,,	,,	·65 *a*	,, ,,	18·5
,, 600 ,,	,,	,,	·65 *a*	,, ,,	18·
,, 700 ,,	,,	,,	·65 *a*	,, ,,	17·5
,, 800 ,,	,,	,,	·64 *a*	,, ,,	15·5
,, 900 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 900 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 1,000 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 1,100 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 1,200 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 1,300 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 1,400 ,,	,,	,,	·64 *a*	,, ,,	15·2
,, 1,500 ,,	,,	,,	·63	,, ,,	13·7
,, 1,600 ,,	,,	,,	·63	,, ,,	12·7†

This gives a little history of the changes of the filament during its life. The tale told may be summarised as follows:—That during the first 200 hours the resistance decreases slightly, with consequent increasing brilliancy. These conditions remain nearly stationary for the next 500 hours. After that they alter perceptibly, increasing in resistance and decreasing in brilliancy in a progressive ratio.

But it must not be forgotten that the increase in resistance of the filament is not the sole cause of the loss of light. As the filament ages, its original smooth surface roughens, and is consequently increased in area in larger proportions than it would naturally be decreased by the loss of bulk. The larger surface requires more current, whereas the increased resistance is gradually reducing the supply.

Another cause of the loss of light is due to the blackening of the glass by a carbonaceous deposit, which also increases with age. This latter loss in 1,000 hours' consumption amounts, in a good lamp, to 15 per cent.

This clouding over of the lamp bulb is due to an internal deposit due to the disintegration of the material, either of the wire mount or of the filament.

Dr. Fleming gave the Physical Society in 1883 and in 1885 a description of some curious phenomena incidental to this aspect of the use of glow-lamps.

It is sufficient for our purpose to mention the cause and the effect.

As time goes on in the life of a glow-lamp a smoky deposit is apparently inevitable; but, quoting Dr. Fleming, "In normal use, when the lamp is not being pressed beyond the E.M.F. at which it is intended to be used, there is a general evaporation of carbon going on from all parts of the loop."

His experiments tended to show that when an excessive temperature is given to the filament by a higher E.M.F., the molecules are projected with violence against the glass, causing by the more rapid disintegration an earlier obscuration of the globe than should arise under normal conditions of consumption. The rate at which the clouding takes place is rapid in the case of some defective filaments. But, as a rule, makers have conquered this difficulty, and it takes place under conditions which are preventable. The loss of light is very slight, and the appearance of a clouded lamp by day-light is, I think, its most objectionable feature.

Any user of glow-lamps on his own installation will find, when he replaces old ones by new, that the latter will give more light, so that, if he introduces a new lamp to replace one which has been broken at a period when most of the lamps are, say, 900 hours old, he will perceive a difference of about two or three candles, if he uses seventeen candle-power lamps. If the old lamps are, say, 1,700 hours of age, he may find a difference of seven or eight candles. As the current is not economised in proportion to the loss of light, he should

* 3·4 watts per C.P. † 5 watts per C P.

recollect that a point may be reached when, by continuing the use of old lamps, there arises an important waste of power. Hence the public should judge of the efficiency of lamps, outside certain limits, more by their constancy of candle-power than by their length of life. Thus the best lamp is that which lives the longest with least variation of light.

Next we may consider the test for vacuum, which in a laboratory can be made with the induction coil as already mentioned by the following test:—Hold the lamp in one hand, and bring the leading in wires in proximity with the pole of a high potential induction coil. If the vacuum is bad, a considerable glow is visible inside the bulb; if good, the glow decreases, and will be evidenced by the length of the spark between the coil and the wires, so as to be almost invisible, and the spark outside is very faint and short.

The vacuum test may also be made by the measurement of heat, to which a lamp burning for a given time will raise a given volume of water in which it is immersed, but this test has one defect, due to absorption of radiation.

Another, but a rougher test, is one which is made by sealing off the lamp with a short length of the vacuum tube attached, and then cutting or breaking its end under mercury, when a bubble denoting the presence of air if it exists will be detected as soon as the mercury has risen into the bulb.

The users may make an approximately good test by observing the presence of luminosity when a lamp is rubbed with the fur of a cat's skin in the dark, or by the touch. The temperature of the external surface of the bulb, after it has been alight an hour or so, will show undue heating, which will signify the existence of a bad vacuum.

The scientific test of the candle-power of these lamps involves us in the form of photometer to be used, and above all the standard of light. The latter is a question which is still under the consideration of a Committee of the British Association. It appears to me that it is not much nearer decision than it was when brought before the Congress of Electricians at Paris, in 1882, when the Carcel lamp and the candle still had their supporters, but there may be members of the committee present who can enlighten us thereon.

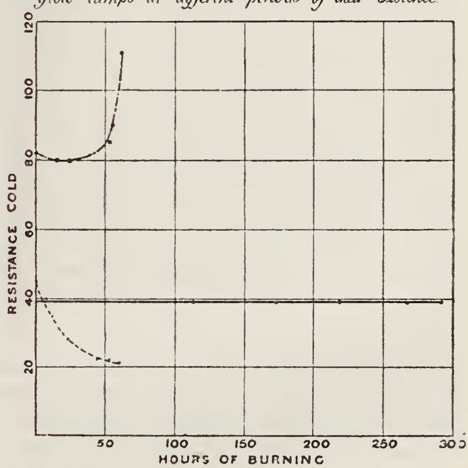
For manufacturing purposes it is the practice, as I have shown is done by Dr. Fleming, to use standard glow-lamps, which are frequently renewed before they have time to deteriorate. These standards are obtained by photometric comparision with flames or sections of flames of known value; ultimately referable to an average of a series of tests with the standard sperm candle. But when it comes to competition tests between the lamps of various makers, that which is most relied on is the life test, for although that test is also a trial of the carbon, it is now generally understood that most fairly well-constituted filaments, will live in a really good vacuum.

To consumers the life test is a matter of economy. They can easily be brought to understand that if their lamps are used with a higher E.M.F. than that for which they were made, over-incandescence takes place, as well as the "clouding" already referred to. This is commonly called "overrunning" lamps, and it is very easily brought about by want of arrangement at the source of the current to

Fig. 5.

Curve I.

Shewing variation of resistance (cold) of various glow lamps at different periods of their existence.



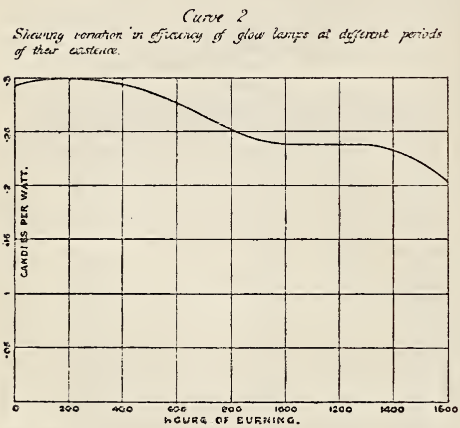
secure regulation of the pressure. Often the purchaser of lamps condemns them for their short life, not knowing that all along it is his own fault, and that, through frequent over-incandescence, his eye has lost the power to judge, even approximately, of the candle-power he is extracting from them. It is not to be expected that he should have a photometer in his house to check this, but it is not too much to require him to have a voltmeter at a point where he may occasionally test for himself whether the potential between his mains is dangerous to the endurance of the filaments in his lamps. If, however, his lamps

behave as those did as shown in the Table already mentioned, he should observe his volt-meter with the view to underrun them in adolescence, so that a healthy maturity and vigorous old age may follow.

There are those present to-night, I believe, who can give the audience very interesting information on these matters.

In some lamps, defective cementation of the filament to the wire mount shows itself after a short life by a giving way or a fracture at that point; but no eye test can, beforehand, detect the liability to this fault. It is said that there is a greater tendency to give way at the junction with the negative metal pole, and from this it has been suggested that, when alternate currents are used, their liability to

FIG. 6.



failure would be modified. It will be very instructive if some one of my audience can enlighten us this evening as to the effects on filaments by the use of alternating currents.

Time does not allow of my touching on several points of interest in connection with glow-lamps brought before electricians in late years by Mr. Wilhelm Siemens, of Berlin, by Crouto, of Milan, and by Bernstein in this country.

I trust my audience will realise that my object this evening has not been to enter on too technical or debateable ground, but rather to engage their interest in the subject from its industrial point of view; and that they will also look with approval on my abstention from touching on the patent and legal part of the question, which has so long been, and still is, a matter of controversy.

DISCUSSION.

The CHAIRMAN said General Webber had done well in bringing before the Society of Arts the special points of interest and importance in connection with the use and manufacture of glow-lamps. It was of interest to know that it was possible to have such a practical system of illumination unobjectionable from a sanitary and economic point of view, and also to see the process of making and testing the lamps. A great deal might be said in favour of the beauty of the appearance of the lamp as compared with other sources of light. It was somewhat difficult to deal with the subject without treading on the toes of inventors, but, with his usual courtesy, General Webber had been exceedingly careful in this respect, and yet had described the general features common to all incandescent lamps. It might not be amiss, as a matter of history, to draw attention to the characteristic curves of different glow-lamps, and to the state of knowledge which existed on the subject in 1882, when a complete series of tests were made at the Crystal Palace Exhibition. There were no long time tests then, because incandescent lamps had not been put to the test, and no one could tell what was the average life of a lamp. The tests made on this occasion were represented on the diagram on the wall, the curves representing the different incandescent lamps, namely, Swan, Edison, Maxim, the British, and the Brush electric lamps. The candle-power, and watts per candle, were also given. The best result attained at that time was four watts per candle, by two kinds of Swan lamps, the high resistance, and the small eight or ten candle lamp. Next to that came an Edison, which took nearly five watts per candle, and then the others, in the order named. Since that period the characteristic curves of the various lamps had approached nearer to the Swan, and had attained to an economy of three watts per candle, but in the meantime the Swan lamp had also been improved, and Mr. Swan was to be congratulated on the very excellent lamps which he had produced. His latest productions were still improvements on those which went before. He did not think electricians would approve of the use of earth in place of the insulated wire to the dynamo, as suggested by General Webber. Surely this would be an element of disturbance, and of considerable danger in the case of machines of high potential. With regard to the concealment of the lights, there might perhaps be some who were of opinion that the objection to the glow-lamps resulted from our being unaccustomed to the light, so that we were tempted to look directly at it. No objection was made to the sun being in full view on a bright sunny day, because, being accustomed to it, we did not look directly at it.

Mr. W. H. PREECE, F.R.S., said he would have preferred that some gentleman who had had practical

experience in the manufacture and testing of lamps had commenced the discussion upon a paper which was extremely interesting, not only from its substance, but from the fact that the great majority of those present had seen an operation performed which was itself unique, and rather out of the reach of the many. The Chairman had very justly complimented the reader of the paper on the tact and skill with which he had held aloof from all matters *sub judice* affecting patents and invention rights, but he thought some reference might have been made to Mr. Edison and Mr. Swan. Whatever might be the rights connected with patents, there could be no doubt that the growth of the electric light industry was greatly due to the activity of Mr. Edison and Mr. Swan, and he did not think they would be just to these two men if they did not mention them. The term "glow" lamp, which had been accepted by the reader of the paper, was one which ought to be generally adopted, and he believed it was first brought out in that room by Sir William Siemens. Reference had been made to the remarkable property which the eye had of adapting itself to different circumstances, and they bemoaned the fate of their ancestors, who had to eat, drink, and be merry under the influence of a rush-light; but his impression was that our ancestors were just as happy under the gleam of the rush light as we were under the brilliance of the glow-lamp, and this was due to the fact that the eye adapted itself to circumstances. One of the most important points which had been dwelt upon was the life of the lamp, and the various improvements which had been made during the last few years to secure this extra life, but he did not think they could congratulate themselves upon the longer duration of the lamp. His own complaint was that the lamps were too long lived. In 500 hours a 16-candle lamp descended to about 8, as a rule; what was wanted was a lamp which would maintain constancy, and there was no mode of attaining this more effective than the use of secondary batteries. It was not possible for any isolated installation to be effective or complete unless there were secondary batteries, as had been fully demonstrated in the lighting of the room in which they were now assembled. The amount of money saved in renewing the lamps alone would repay the interest on their cost. With regard to the manufacture of glow-lamps, it could not be denied that this was increasing very fast; only the other day, he heard that at Edison's factory they were turning out about 3,000 a day; and from a rough estimate which he had made, he found that during the last four years the manufacture had increased so fast, that probably at the present moment 10,000 lamps were made daily, as compared with 10 a day four years ago. He did not agree with the Chairman in his condemnation of the use of earth, nor did he understand General Webber to advocate the use of earth, but only to speak of the use of the return wire in the electrician's meaning of "earth."

Prof. AYRTON, F.R.S., thought one reason why the name "glow" lamp had been so slow in coming into use was because the name suggested a feeble sort of light as compared with incandescence, which suggested a bright light. The question of shading the light from the eye was a very important one, and it was a subject on which it was very difficult to say what ought to be done. The Chairman took the view that people ought to see the light and get used to it; and Mr. Preece had followed in the same direction, saying that the eye adapted itself to the light with which it had to deal. But was that quite true? The Commission which sat some time ago in Germany, America, and in other countries, on short sight, came to the conclusion that children became short-sighted owing to the bad light in schools. The Japanese English-speaking students, who, as a class, were very short-sighted, attributed short sight to reading small English type in a bad light. Might not harm be produced by too bright a light? An incandescent lamp of 10 candles hurt the eyes, but a candle did not, because the filament of an incandescent lamp gave a sharp bright line of light, which a candle did not, and a bright line of light was very painful to the eyes. The reason why the sun did not affect one's eyes was because the rays were not like a sharp line of light in the dark; secondly, because the sun was not looked at; and thirdly, because people in London did not often have a chance of doing so. He could quite bear out all that had been said as to the experiment in the Albert Hall; the effect of putting the lights in the boxes concealed from view was extremely charming. On the question of efficiency, as attention had been drawn by the Chairman to some experiments made at the Crystal Palace, he should like to ask whether the results fairly represented the value of the lamps. He thought they did not, unless they could be assured that the lamps used were guaranteed by the makers to be all emitting the same amount of light. If the lamps were intended to give a different amount of light, it was not fair to test them with the same number of watts. No doubt with the Maxim lamp, which was intended to give out a large number of candles, you would only get very few candles with a small expenditure of power, but that did not show that the lamp was inefficient in any way. Experiments made by the speaker in conjunction with Professor Perry at the Electrical Exhibition in Paris, showed that a Maxim lamp could be run up to 1,200 candles for a few minutes, and that the efficiency was then equal to an arc lamp. It would not, however, be fair to conclude that the commercial efficiency of a Maxim lamp was equal to that of an arc lamp, for a Maxim lamp would only live for a few minutes when giving 1,200 candles. Indeed, it was meant to give off fewer candles than 1,000; in the same way, it was not fair to compare its efficiency, when only giving ten candles, with other lamps intended to give only ten candles, because the Maxim lamp was intended to give far

more than ten. In fact, the only fair way to compare lamps was to measure them at the candle-power at which they were intended to burn. The curves shown by the Chairman were no doubt extremely interesting in 1882, but they did not give any idea of the commercial value of the particular lamp. Many tables had been published showing the life of lamps, but most of these were mere calculations, as he had himself proved. On one occasion a Frenchman brought him a table of an experiment which was said to have taken place in France, showing the number of thousand hours the lamp had burnt with the use of 70 volts, and on working it out he found that the experiment must have been commenced long before the incandescent lamp was invented. He should like to know whether anyone had found that lamps which were turned on and off constantly had a shorter life than those which were not. He had seen it stated as a fact that when lamps were solely with accumulators, they had a far longer life than when burnt with the best compounded dynamo, and he should like to know whether this was true.

Dr. FLEMING said an incandescent lamp was not only a useful thing, but it had about it many points of great interest in physics. Many persons had the impression that the interior of a glow-lamp was a place that was empty of all air particles, but this was not the case, it was as full as it well could be. Maxwell had shown that in a small cube of 100,000th of an inch, there would be found 100 million molecules of ordinary air, so that in a cubic inch of air there were a number of molecules represented by 100,000,000,000,000,000. In a Swan lamp, when exhausted to one millionth of an atmosphere, there remained some 400,000,000,000 molecules of air. As it took about ten days to count a million, a simple calculation would show that to count the number of molecules in such a vacuum would take 120,000 years of continual counting. The fact that the glow-lamp was as full of molecules as it well could be led to many interesting consequences. The atoms were however, so far apart, that any one of them could go from one side to the other without coming into collision. In an ordinary glow-lamp when burning, from all parts of the carbon filament molecules of carbon were being thrown off by the heat, which gradually produced the cloudy appearance that was sometimes seen. If this went on equally, the darkening was equal, but in a glow lamp the heat was greatest where the resistance was greatest, so that if by accident, on any part of the filament there was a spot of greater resistance, the scattering of molecules would take place quicker at that part, and the filament would be cut through. The greatest projection of molecules would take place to the parts of the glass which were not shielded by the loop. He held in his hand an Edison glow-lamp, clouded with transparent copper, which had been deposited from the clamps in burning. With regard to testing incandescent lamps, there was no difficulty in making electrical measurements with any degree of accuracy, but what could not be done was to measure the illumination with equal degree of accuracy. The plan of measuring glow-lamps by means of candles was a barbarous one, and ought to be got rid of, as a standard candle would vary to any extent up to 20 per cent. Therefore, until they got something more accurate as a standard light, research could not be pushed forward with any degree of accuracy. A suggestion was made at the Paris Exhibition to use melting platinum for a standard of illumination, but nothing had as yet been done in this direction. It was probably possible to use as a standard the radiation from a material such as carbon, in which was being wasted, from a definite surface area, a definite quantity of electric energy per second, and by this method they would have better means of carrying on the investigation of characteristic curves and the question of illumination. The standard which he used was Siemens's acetate of amyl lamp, which gave very fair results, and, besides this, there was Methven's gas-flame standard, and Harcourt's air gas-flame standard, which gave fairly good results.

Professor FORBES considered that the process of manufacturing glow-lamps, which had been exhibited that evening, was most interesting. He had been struck with several points of improvement which had lately been introduced, but in the manufacture of filament he considered many makers had not advanced one single step in four years, as they used the same substance and prepared it in the same way as previously. They were still in want of statistics of definite data, showing what advantage had been gained by the process of manufacturing by squeezing through a die. One improvement which had been effected was in the way of attaching the filament to the platinum terminals. He was surprised to find that but little progress had been made in the improvement of pumps for producing the vacuum, and considered that the use of an india-rubber tube for connecting the pump and lamp was a mistake, and should be avoided; but as the question of exhaust pumps was to form the subject of a future paper, he would not further touch upon this point. Various speakers had touched upon the standard of light, and General Webber had expressed an opinion that they were in the same position as they were several years ago; but upon this he ventured to differ as he considered they were far ahead of what they were a few years back. The B.A. committee, of which he was secretary, had been carefully studying the subject, and though many thought it was a slow process of elaboration to get a standard from the gradual way in which the committee had been working, yet he believed every one would agree in the end that it was not wise to jump too hastily at a conclusion. Dr. Fleming had said that he thought a standard of light should be produced by electric energy,

but there were two difficulties in the way: first, you had to know what was the temperature of your standard; two equal areas of incandescent material, might be using up the same electrical energy and yet the light be totally different; and in the second place, the whole of the energy being used up, was not utilised for the purpose of light. The question was not quite so simple as it appeared, but he hoped that in time such a standard might be obtained, though at the present moment the experiments which had been made did not tend to make them hope very much that they would be able to determine in any convenient manner the temperature of an incandescent material rendered incandescent by a current of electricity.

Professor SILVANUS THOMPSON said he happened to know that many improvements had taken place which had not been referred to by General Webber; and in the report of a certain law-suit there was reference to a mysterious process called "running on the pump." Whether the processes were universally known or not he could not say, but it was quite possible that there might be a few details which had not been revealed in the account of how glow-lamps might be made. As a rule, it was found when lamps failed that it was through a fracture of the bridge just above the joint where it was cemented to the wire which led in, but very often the fracture took place not at the heel of the bridge, but just below the crown of the bridge. He should like to know why it was that this occurred; had it anything to do with the bending of the material in the process of formation, or had it anything to do with the distance between the bridge and the surrounding bulb? It had been suggested that electricity possessed a sort of inertia, and did not like to go round a bend, but he could not quite agree with this view, and should be glad of any information upon the point. He considered a great advance had been made in the selection of proper materials for the construction of the bridges. In America one good maker used silk as material. He quite endorsed the remarks which had been made by Professor Ayrton as to the curves, believing that to judge all lamps by their efficiency when giving 10-candle power was unfair, as many lamps were not made to be used at 10 candles. He considered the use of the word "filament" for the conductor or bridge a misnomer, as it was misleading; it should be called a "strip," or a "wire." To give the new name of "filament" to that which was perfectly known before as a carbon wire or carbon strip did not constitute it a new invention, though it might be very clever to invent a new name for an old thing.

Major-General WEBBER regretted that Professor Forbes should have been disappointed in not seeing the newest form of vacuum pump. The one exhibited was the simplest and most suitable for a lecture-room. It would take a whole course of lectures to bring before the public the special devices and processes which in some parts of the paper had only been alluded to by a single word. For the exhibition which he had been able to produce that evening, the thanks of the members were due to the Directors of the Anglo-American Brush Corporation, who had placed their apparatus at his disposal, and to the officers and assistants of the Company for the hearty way in which they had come forward and helped him by showing so accurately and carefully the processes in which they were daily engaged. He thought the warmest thanks of the meeting were due to them, as well as to the worthy Chairman.

On the proposition of the CHAIRMAN, a cordial vote of thanks was passed to Major-General Webber for his valuable and interesting paper, and to those who had assisted him in carrying out the different processes of manufacture.

Notes on Books.

REMINISCENCES OF THE COLONIAL AND INDIAN EXHIBITION. With Illustrations by Thomas Riley. Edited by Frank Cundall. London: William Clowes & Sons.

This is a collection of sketches, upwards of one hundred in number, of the Exhibition by Mr. Riley, who designed the diploma for the last three Exhibitions, the letterpress being supplied by Mr. Frank Cundall, a member of the Executive Staff of this and of the three previous Exhibitions. There are two coloured plates, one representing "The Opening Ceremony," and the other from an oil painting, "Silk-Weaving in the Cyprus Court." Seven of Mr. Riley's illustrations are etchings, two of them being portraits of H.R.H. the Prince of Wales, and of Sir Philip Cunliffe-Owen, the Secretary to the Royal Commission. The other five are, a view of the "Old London" street, the Indian Palace, with the Hall of Columns, and from the Durbar Hall, the Gardens, showing the Malay House, and a group of Indians from British Guiana. The remaining illustrations are all from "surface" blocks printed with the type, some being reproductions from pen-and-ink sketches, and the rest from pencil sketches, or pictures in oil and in water-colour. All the illustrations (excepting the coloured plates) have been produced without the intervention of any hand, except that of the original artist. The book therefore affords an excellent example of the extent to which the ancient art of the wood engraver has been replaced by more modern processes, giving as it does not only examples of the methods in use for reproducing in *facsimile* work drawn in line by the artist, but also specimens of the more recent devices for translating into line or stipple shaded and even

coloured drawings without the intervention of a second hand.

The letterpress gives a succinct history of the Exhibition, and a brief account of its most interesting and important features. In an appendix are given lists of all the various commissions connected with the Exhibition. The book is published with the sanction and approval of the Royal Commission, and is dedicated, by special permission, to her Majesty the Queen.

By permission of Messrs. Clowes, the publishers, the engraving of the Exhibition Diploma is reproduced as a supplement to this week's *Journal*. The original is a chromo-lithograph from a water-colour painting by Mr. Riley. The following is the description given in the "Reminiscences":—"Britannia seated on the right, supported by Commerce and Industry, is receiving the Colonies, each of which is represented by a single female figure. India holds a jar containing spices; Canada, with a Red Indian head-dress and a fur-lined cloak, bears a calumet; Australia, on whose dress kangaroos are embroidered, carries a sword, in allusion to the aid which New South Wales promptly rendered in the Soudan campaign; New Zealand bears a Maori paddle; the West Indies offer sugar-cane; the Cape holds ostrich feathers; Burmah offers a bead necklace; Malta has a spear; Cyprus is typified as Venus, and the other colonies are identified by typical produce or emblems. In the background is Britannia's realm—the sea, with a suggestion of the white cliffs of Albion, a fort and a quay. On the sea is one of the seven troopships, which are ever engaged bearing soldiers to and from the Indian Empire."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

December 15.—Adjourned Discussion on Dr. C. Meymott Tidy's paper on "Treatment of Sewage."

Cantor Lectures.

The First Course is on "Principles and Practice of Ornamental Design." By Lewis Foreman Day. Four Lectures.

Lecture III.—December 13.—*The Fitness of Ornamental Form.*—The adaptation of ornamental form to considerations of use and workmanlikeness. Style and ornament evolved out of the characteristic handling of the tool. Where to stop.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "The Principle and Practice of Ornamental Design." (Lecture III.)

Geographical, University of London, Burlington-gardens, W.C., 8½ p.m. Major C. R. Maggregor, "Journey of the Expedition under Colonel Woodthorpe, R.E., from Upper Assam to the Irawadi, and return over the Patkoi Range."

Tuesday, Dec. 14...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Dr. John Hopkinson's paper, "The Electric Lighthouses of Macquarie and of Tino."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8 p.m. 1. Rev. George Brown, "Papuans and Polynesians." 2. Mr. A. W. Howitt, "Notes on Songs and Song Makers of some Australian Tribes." 3. Dr. G. W. Torrance, "Music of the Australian Aborigines." 4. Mr. R. H. Bland, "The Aborigines of Western Australia."

Wednesday, Dec. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Dr. C. Meymott Tidy's paper, "Sewage Disposal."

Meteorological, 25, Great George-street, S.W. 7 p.m. 1. Mr. G. J. Symons, "The Proceedings of the International Congress of Hydrology and Climatology at Biarritz." 2. Rev. T. A. Preston, "Report on the Phenological Observations for 1866." 3. Prof. S. A. Hill, "A Criticism of certain points of Prof. Langley's Researches on Solar Heat." 4. Mr. R. L. Holmes, "Account of the Hurricane of March 3rd-4th, 1886, over the Fiji Islands." 4. Mr. W. H. Lyne, "Results of Meteorological Observations made at the Military Cemetery, Scutari, Constantinople, 1866-85."

Geological, Burlington-house, 8 p.m. Prof. T. Rupert Jones, "Notes on *Nummulites elegans*, Sow., and other English Nummulites." 2. Mr. A. Smith Woodward, "The Dentition and Affinities of the Selachian genus, *Ptychodus*, Agassiz." 3. Mr. R. Lydekker, "A Molar of a Pliocene *Equus* from India."

Institute of Bankers, Theatre of the London Institution, Finsbury-circus, E.C., 7 p.m.

Shelly, University College, Gower-street, W.C., 8 p.m. Mr. W. M. Rossetti, "A Study of Prometheus Unbound."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. Pollard Urquhart, "Copper Production in the South of Spain."

Thursday, Dec. 16...Linnean, Burlington-house, W., 8 p.m. 1. Professor F. O. Bower, "Apospory and Allied Phenomena." 2. Dr. G. J. Romanes, "Experiments on the Sense of Smell in Dogs." 3. Mr. C. T. Druery, "A New Instance of Apospory in *Polytrichum angulare*."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. R. Meldola and Mr. F. W. Streatfield. "Researches on the Constitution of 'Azo and Diazo-derivatives.'" (I. Diazoamidao-compounds.) 2. Mr. Thomas Turner, "The Influence of Silicon on the Properties of Iron and Steel."

East India Association, Westminster Town-hall, 2½ p.m. Mr. Maneckjee Byramjee Dadabhoy, "The Needed Reforms in the Administration of British India."

Historical, 11, Chandos-street, W., 8 p.m.

Friday, Dec. 17...Civil Engineers, 25, Great George street, S.W., 7½ p.m. (Students' Meeting.) Mr. C. E. Davenport, "Water Supply in Rural Districts."

Philological, University College, W.C., 8 p.m. Mr. H. Sweet, "The Laws of Sound Change."

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FRIDAY, DECEMBER 17, 1886.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given on Wednesday evenings, January 5th and 12th, 1887, by Professor A. W. Reinold, F.R.S., on "Soap Bubbles." The lectures will commence at seven o'clock. Nearly all the tickets having now been disposed of, the issue will be stopped on Monday next, December 20th. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member will be admitted without a ticket.

APPLIED ART SECTION.

A meeting of the Committee of the Section of Applied Art was held on Wednesday, December 15th, at 4 p.m. Present: Sir George Birdwood, M.D., LL.D., C.S.I., in the chair, Mr. T. Armstrong, Mr. B. Francis Cobb, Colonel Donnelly, C.B., Mr. R. W. Binns, F S.A., Mr. Walter Crane, Mr. J. Hunter Donaldson, Mr. Henry Doulton, Capt. Douglas Galton, C.B., D.C.L., F.R.S., Mr. George Godwin, F.R.S., Mr. Ernest Hart, Sir T. Villiers Lister, K.C.M.G., Mr. Alfred Phillips, Mr. J. Hungerford Pollen, Mr. E. C. Robins, F.S.A., Mr. Vincent Robinson, Mr. W. Simpson, Mr. J. Sparkes, and Mr. R. Phené Spiers, F.S.A., with Mr. H. Trueman Wood, Secretary of the Society, and Mr. H. B. Wheatley, Secretary of the Section. The following days were selected for the meetings:—Tuesdays, February 1, 22, March 15, April 26, May 10, 24.

The programme of papers to be read during the present session was discussed.

CANTOR LECTURES.

Mr. Lewis Foreman Day delivered the third lecture of his course on the "Principles and Practice of Ornamental Design," on Monday evening, 13th inst. The particular subject of the lecture, which was the fitness of ornamental form, was illustrated by a series of diagrams showing the adaptation of form to the purposes required by the design. The lecturer explained the meaning of the term conventional, and laid particular stress on the need of adapting the design to the character of the material used.

The Lectures will be printed in the *Journal* during the Christmas recess.

THE IMPERIAL INSTITUTE.

H.R.H. the Prince of Wales has appointed Sir Frederick Abel, C.B., F.R.S., D.C.L., to represent the Society of Arts on the Committee of the Imperial Institute.

THE JOURNAL.

The Secretary will be greatly obliged if the members of the Society will inform him at once of any irregularity which may occur in the delivery of the *Journal*.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Two Gold Medals and Four Silver Medals for prime movers suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows:—

1. The motors will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class.

(A.) Motors in which the Working Agent is also Produced.

Steam.—Ordinary portable or semi-portable non-condensing engines.

Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer.

Petroleum vapour.

Liquid petroleum.

(B.) Motors to which the working agent must be supplied.

Steam.—Detached engines, non-condensing, without boilers.

Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas.

Hydraulic.—Water motors.

2. Each class will be subdivided into two groups—those declared to develop not more than 10 h p., and those which will develop more than 10 h.p. and less than 20 h.p.

[The horse-power herein mentioned is equivalent to 33,000 lbs. raised one foot high in one minute, as measured on the brake.]

3. The entrance fee will be £2 10s. per h.p., to be paid on entry.

4. No competition will be held unless ten motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The Council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the Regulations of the Royal Agricultural Society, viz. :—

a. All boilers must be fitted with a steam pressure-gauge. Before any engine can be worked, the pressure gauge must be verified by the judges.

b. There is no restriction as to the construction of steam-engines or boilers, but the judges must be satisfied that the bursting strength of the engine or boiler is at least four times its working pressure, and that a hydraulic test of one and a half times the working pressure has been satisfactorily applied.

c. Each exhibitor must declare the greatest pressure at which he proposes to work his boiler or engine.

d. No old boilers, that is boilers that have manifestly been at work for a considerable time, will be admitted without special thorough examination and a certificate of safety from the judges.

e. Each boiler, of whatever form or size, must be provided with the following mountings:—

Two Safety Valves, each of sufficient size, to let off all the steam the boiler can generate, without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set.

Two Sets of Gauges for ascertaining the water level.

One Steam Pressure Gauge, which must be tested and verified by the judges before the boiler can be used.

A Half-inch Cock, terminating in a half-inch male gas thread, for the purpose of receiving a testing pump.

One Check Feed Valve, immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water-level, or where there is a length of feed pipe between the engine and boiler.

f. Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges require it.

g. Shafting, belts, gearing, high speed machinery, and any other exhibits likely to prove dangerous, shall be securely fenced and protected to the satisfaction of the judges, but such approval shall not relieve the exhibitor from his own liability.

8. The points of merit considered of the greatest importance are—

a. Regularity of speed as to revolutions per minute under varying loads.

b. Regularity of speed during the various parts of one revolution.

c. Power of automatically varying speed to suit arc lights.

d. Noiselessness.

e. First cost.

f. Cost of running.

g. Cost of maintenance.

9. The tests will be carried out under the direction of three judges appointed by the

Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal* of the Society of Arts. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the Society, all claims in respect of damage (if any) resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

13. All costs of fitting up and working the motors must be borne by the exhibitor. The Society will provide the brakes, indicators and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 15, 1886; Captain DOUGLAS GALTON, C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society :—

Baker, Walter Joseph, 160a, Southwark-bridge-road, S.E., and Wallington, Surrey.
Bradford, William, Carlton-chambers, 12, Regent-street, S.W.
Carter, James Harrison, 82, Mark-lane, E.C.
Etherington, John, 39a, King William street, E.C.
Forrester, Thomas (Mayor of Chorley), Crosse-hall, Chorley, Lancashire.
Mason, Thomas G., 32, King-street west, Toronto, Canada.
Wakefield, Charles Leonard, Lloyds, E.C.
Wigley, William Charles, 29, Stoke Newington-road, N.

The following candidates were balloted for and duly elected members of the Society.

Berry, Henry Percival, 3, St. James's-street, S.W., and 14, Westbourne-villas, West Brighton, Sussex.
Bowring, Algernon C., 30, Eaton-place, S.W.
Buck, Sir Edward C., Calcutta.
Courtney, Frank Stuart, Palace Chambers, 9 Bridge-street, Westminster, S.W.
Horrocks, Joseph, 10, Union-street, Southport.
Reynolds, Edwin A., Holborn Sanitary Engineering Works, 82, Belvedere-road, Lambeth, S.E.
Seward, Edwin, St. John's-chambers, Cardiff.

The adjourned discussion on the paper by Dr. C. Meymott Tidy on "Sewage Disposal" (delivered April 14, 1886) was resumed.

Sir ROBERT RAWLINSON, C.B., in opening the discussion, said he could not plead ignorance of the question of the treatment of sewage, because officially he had been bound o pay attention to it, and had been in contact with it under most of its forms, so far as it had been dealt with. No man had a higher respect for Dr. Tidy's talent and ability, but it was not given to every man to have had practical experience in all that he was now called upon to speak about, and Dr. Tidy would not be offended if he said that he had not had that practical acquaintance with the different modes of dealing with sewage which he (Sir R. Rawlinson) had. Sewage had to be considered under several aspects, but before considering the question of sewage proper, he would touch on one or two methods of dealing with excreta which had been referred to by Dr. Tidy in his paper. The question whether excreta should be removed from every house by the dry earth system, the moveable pail system, the Goux system, or by water-carriage, required very grave consideration. Now if anyone imagined that towns could be dealt with on the dry earth system, he pitied their ignorance. If they thought towns could be dealt with on the moveable pail system, he only wished they could see those pails manipulated, for if they were compelled to do so, they would start back in horror from the idea of such a system being continued. Then there was the water-carriage process—that was to say, sewering and draining. But there were different kinds of sewering and draining. Sewers might be very imperfect, drains might be very improperly constructed, and be imperfect, and great evils might arise from sewering and draining. But according to the best modern processes of sewering and draining, he maintained that, for town populations, that was the only real method of passing excreta away from populations without causing injury. To do that, the sewers must be perfectly water-tight, absolutely true in form and construction, laid out with judgment, and properly ventilated. If houses were to be drained, each house must be in itself so drained that it should stand as absolutely free from the sewer into which it passed its fluid as if it stood in the middle of Hyde-park or in a ten-acre field. It was quite possible so to drain houses, and so to sewer towns that there should be absolute isolation, that was to say, that the houses should be cut off from the flow-back of the sewage,

or any portion of sewage gas. In London, there were large houses so drained, which were as completely severed from the sewers which received the sewage as if they were a mile away. Those very houses before they were so dealt with were simply great retorts, into which the concentrated sewage gases of the foul sewers of London penetrated from the basement up to the attic. Having said so much as to his idea of what town drainage ought to be, he would say this in favour of earth-closets, that for country houses and villages, where the population was thin and scattered, they might be used with advantage. If he lived in the country, and employed a gardener, he certainly would have an outside earth-closet for males, because it could be so arranged as not to be a nuisance; but it must be attended to daily by the servant in charge. Earth-closets in houses were simply an abomination, and no care or arrangement could make them otherwise. As to pails, whether they were in yards or back premises, they were filthy, stinking abominations, and it was no use to tell him that the excreta collected from them could be taken to a depôt, and so manipulated as to be turned into a valuable manure. Supposing that to be true to the uttermost, his reply to the projectors of that method would be—You have not the slightest right to trade upon the health and comfort of the community; it is no part of your business to make money out of excreta if it annoys one single human being, but it is your duty to scavenge so perfectly as to remove all cause of nuisance, and all chance of danger. That was the doctrine which he preached. He had been to towns where he was told that the excreta was removed in pails, and manipulated, and that the resultant compound was sold for £3 10s. or £4 per ton; but if they had told him that it was sold for £30 or £40 a ton, and could prove it, and he could turn round to the population and see that fever had been engendered, and that misery and nuisance had been occasioned by the retention of the pails on the premises, he would denounce the plan. It was not a question of making money, but a question of health. With regard to dealing with sewage by chemical precipitation and irrigation, when he began to speak of chemistry before Dr. Tidy, he hoped he might be pardoned if in his remarks he betrayed his ignorance. He was not a chemist, but an engineer. In chemistry he understood that when substances were put into fluids, or when changes were made in fluids, that some equivalent was given for the thing to be removed; that is to say, if you treated sewage with chemicals by precipitating something which was noxious in the sewage, you imparted to the effluent some portion of the material that was put in to produce that. When what was called a good effluent was produced, and it was sent out in a dry season into a comparatively dry water-course, it not only set up a renewed nuisance, but if there were milch cows on the land, it poisoned the milk. He was not speaking speculatively, but from what had been brought to his attention, and what he believed. His experience with regard to sewage now extended over some thirty years; and he must say that no institution had done so much as the Society of Arts in investigating and promoting investigation into this subject. He had served on three Royal Commissions, and the result of all came to this. The question of precipitation or irrigation might be condensed into a few short sentences. Where it was not possible to get land for broad irrigation, precipitation must be resorted to. Where that was done, you must have sufficient tank room, allow sufficient time, use the best ingredients, and, above all, unceasing and intelligent care must be bestowed on the process. The best chemical formula would be absolutely worthless if the works were neglected. This being so, the local authorities had to use their best efforts, and then came in the question of cost. As far as his experience went, to treat sewage by chemical deposition would not cost less than £1,000 per annum for each million gallons per day so treated. In some cases the cost would be double that, but in large towns that figure would probably be sufficient. They were told strange stories about the material which was precipitated in the tanks; that in some places it could be manipulated and sold for £2 or £3 per ton; but he might say he was acquainted with 99 out of 100 of the works in the kingdom, and if the conductors of these could get 1s. per ton for their extracted and machine-compressed sludge they were perfectly satisfied. Most of them could get nothing, and they were very glad to have the material taken away. That being so, he had no explanation to offer as to the high prices to be obtained. In the vast majority of cases where sewage had to be treated, it must be treated for the sake of purifying it and getting rid of a nuisance, and not for the sake of producing income. It had been his fate to investigate almost every sort of scheme which had been brought forward during the last 25 years. He had schemers sent to him by Cabinet Ministers, and many had come to him voluntarily, but he had never yet persuaded a man, or convinced him, that his process would not answer. Over and over again these people had gone away shaking their heads, saying, "Ah! sir, we see you do not understand it." In a few cases, when they had lost all their money and broken down in practice, they came back and said with a sad look, "We wish we had accepted your advice." He thought that if there was any chance of dealing with sewage with the nearest result to profit, it was by what was termed broad irrigation. In some cases, where the land was in sufficient area—where it was of an exceptionally good quality for sewage—crude sewage might be put on direct without tanking, and in cases where an area was less than some 300 or 400 acres, expensive and permanent carriers of any kind were not required. Where the area was from 500 to 2,000 acres, then it might be necessary to construct certain leading permanent carriers over the ground in order to get the sewage on. A vast amount had been wasted in this country by young engineers

laying out small farms of 200 or 300 acres with costly permanent carriers, which had been an obstruction to the irrigation process. What was wanted in those cases was rough and ready carriers made by the spade or the plough, and subsidiary carriers ploughed in. The crude sewage was to be taken to the highest point, and passed along *contour* lines gradually over the land, until the effluent came out at the lowest point. At certain sewage farms expensive depositing tanks had been made to extract the crude sewage, but after the first week or two it was found they set up such an intolerable nuisance, and the land was so favourable for receiving the crude sewage, that the tanks had not been used. He would just name a few of the reports which had been made on sewage. In 1869, there was the inquiry at Barking; in 1876, 1877, 1878, and 1879, congresses were held at the Society of Arts, and as all the facts were embodied in the reports which had been presented, he did not think it necessary to waste further time in dealing with them. Again, there was the inquiry on the pollution of rivers. He reminded his hearers that they were living in London, and he thought they, as well as himself, had been pretty largely concerned in times gone by with the question of metropolitan drainage; and he must say that, at this day, he was absolutely staggered at the apathy of the Metropolitan Board. That Board having been appointed by Parliament to undertake the purification of the River Thames, that was their first duty, and yet they had shirked that duty up to this moment. So far as his knowledge went, the Board did not appear inclined to undertake the duty any further. That inaction was to him a mystery. The process of precipitating the sewage at the Barking outlet, and then barging the sludge down the Thames to the sea, was a monstrous proposition, and one which he could not understand. With regard to precipitation, reasoning from small to large, he found that in a population of 1,000, from sewage tanks about ten tons of wet sludge per week were extracted. This quantity, by presses, could be reduced to two tons. This would give about 104 tons of pressed sludge in one year from each 1,000 of the population, which at 2s. per ton would cost £10 8s. per annum. Taking the population of London at four millions, there would be 40,000 tons of sludge per week, or 2,080,000 tons per year, or 416,000 tons of compressed sludge at 2s. per ton would cost £41,600 per annum, plus any cost of removal. Then, with the chemical treatment, taking the population again at four millions, there would be 165,000,000 gallons per day, or 60,225,000 million gallons per annum to be treated, or about 268,000,000 tons per annum, and to treat this chemically it would cost £11,000 per annum for each million gallons per day, which would give £1,650,000 per annum. The chemical treatment and sludge pressing would, therefore, cost per annum about £1,691,600. To treat the metropolitan sewage sediment chemically and mechanically would require additional tank spaces, additional engine power, and the cost of removing the compressed sludge, for he did not credit the Board with the folly of intending to barge the wet sludge, which would be 2,080,000 tons per year, and would require twenty barges of 1,000 tons each, making two journeys each week. But if they provided the engine-power and sewage conduits, the 268,000,000 tons would flow to any point of outlet without any barging. That was the process by which the metropolitan sewage should be dealt with. There might be an outlet for the sewage to the sea when it could not be dealt with otherwise, but he was perfectly satisfied that, if conduits were judiciously made down to Canvey Island, or anywhere else, and the sewage was passed through an agricultural district, and farmers were allowed to take it or not as they wished, and the Board, or whoever was in charge of the works, had power to purchase at a low agricultural value for the purpose of letting it out for sewage irrigation, in a few years the crude sewage of the metropolis would be utilised between the present works and the sea, not only without any ruinous cost to the parties establishing the works, but with some chance of an income, certainly not with the enormous loss which would have to be faced if the Board went on the present tack of attempting to treat the sewage with chemicals, or adopted the absurd plan of barging sludge, either compressed or wet, down to the sea.

Major LAMOROCK FLOWER took exception to Dr. Tidy's definition of sewage, which included the refuse of communities, habitations, streets, and factories. He wished to leave out the word "factories." The great difficulty in dealing with sewage was found to be in dealing with factory refuse poured into the sewers, and he thought that all manufacturers should be bound to treat their own refuse on their own premises, and he might say that this could be done with economy and with profit to themselves. At a large soap works near London, £5,000 was saved by evaporating the glycerine which went into the sewers and polluted the River Lee. He could name other works in different parts of the country where they made considerable profit by realising the waste products. That led him to speak of the utilisation of waste products and the dealing with sewage, and also to comment on a remark made by Sir Robert Rawlinson as to the discharge of chemical effluents into streams and the reverse, and to mention an extraordinary fact which had come under his notice. At Tottenham, the sewage in very imperfect works was treated by a mixture of lime and a residue of alkali—a manufacture specially prepared by John Hanson, of Wakefield, and turned into the Lee in an extraordinary-looking condition. It was not a good-looking effluent, but the effect of the discharge into the river was to improve the condition of the river. The reverse case was the discharge of

sewage at Hertford. There the sewage was treated chemically, and the effluent when discharged looked something like gin; but in the river it produced a foul condition of things, and the unfortunate part of it was that the East-enders had to drink it. After a storm the contents of the sewers were in their foulest state. Storm water therefore, was, most prejudicial, and should be discharged on the land, or treated before it was allowed to go into the streams. They could not possibly say any one chemical system dealing with sewage was applicable over the whole country. Every case should be treated according to its own topographical position and the condition of the sewage. He thought they should follow the words of St. Paul, to "prove all things, and hold fast that which is good."

Mr. E. Bailey Denton being greatly interested in the sewage question, and having had practical experience in sewage disposal, wished to say a few words on the observations made by the Chairman at the last meeting with regard to irrigation and intermittent filtration. As Sir Frederick Abel's observations carried such weight on all scientific questions, and as his name was attached to a report approving of the present experimental treatment of the London sewage by Mr. Dibdin, the chemist to the Metropolitan Board of Works, he felt obliged to do his best to remove the impressions produced when Sir Frederick Abel inferred, from certain statements of Dr. Tidy having passed unrefuted, that the objections he raised would be fatal to the practical value of sewage disposal by filtration through land—a system especially recommended by the Royal Commission on metropolitan sewage discharge. Dr. Tidy said "the action of land may become ineffective from circumstances over which we have no control, namely, frost, when the ground may become absolutely impenetrable." Now, Colonel Haywood, the City Engineer, proved by experiment that in winter time the mean temperature of sewer air was 11·6° higher than the external air, or practically that when the atmosphere outside was at freezing point, the ground surface would be 31°, and the sewage to be applied to that ground, 43·6. He had constantly seen sewage—especially when distributed in flowing quantities—completely thaw the frozen ground with which it was brought in contact, when it filtered through the soil just as efficiently as in open weather. This has been the case not in one instance only, but in many. A second statement with which Sir Frederick Abel seemed to agree was as follows:—"The ground may become water-logged in times of heavy rain, when the sewage is in far greater quantity than normal, and, for a time at least, more foul than normally, from the flushing of the sewers." His answer was, that if such a state of things were allowed to exist where filtration was resorted to, failure would certainly follow, and therefore it was the engineer's first duty to prevent the possibility of supersaturation, which, to any one who thoroughly understood the principles and practice of drainage and filtration, was quite practicable. With suitable soils, the engineer could at all times properly underdrain filter beds, and, in certain soils, help their porosity by the mixture of gravel, burnt ballast, sand, chalk, &c., &c., so as to enable the liquid under all conditions to filtrate through the soil. Experience of filtration, under varying conditions, enabled him to speak with the greatest confidence of its efficiency, and he was sorry to hear any one of the name of Frankland depreciate the value of deep under-drainage, it being of great importance, not merely from a chemical but from a mechanical point of one. The effect of such an opinion as was attributed to Dr. Frankland as to the necessary depth of aërated soil might induce those members of local Boards who knew nothing about drainage to think a depth of 18 inches sufficient for under-drainage, and so, from a desire to save money, bring disaster upon an otherwise good system. He did not wish to discuss the proper mode of dealing with the London sewage, as his father's name was associated with a permanent and positive means of completely relieving the Thames and Lea of pollution by a scheme known as the Canvey Island scheme, in which mechanical took the place of chemical treatment. At the same time, having spoken of filtration, he might state that an important feature in the Canvey Island scheme was that the crude sewage, having been collected in large earthen basins, should part with its solid matter—held in suspension—on the island, to raise that surface above tidal influence, and that the supernatant water should filter through the soil, thus adding the purification of the liquid to the extraction of the solids before discharge in the estuary. Luckily, in this instance, the tide allowed of this being effected without limit to 18 inches, or any such insufficient depth. If this mode of treating the London sewage were adopted, it had been proved beyond doubt, by those who had devoted an immense amount of thought and labour to the subject, that the material could be taken down to the mouth of the Thames and there treated for a charge upon the ratepayers of not more than 1½d., or, at the most, 1¾d. in the £, or £200,000 per annum; whereas if the experimental treatment at the present outfalls be persisted in, it will cost at least double these figures, and not be a permanent remedy after all.

Dr. Louis Parkes said he would confine his remarks to the one point, whether the sewage farms had a bad influence upon health. That was a very important question, because it was quite certain that the public would have nothing to do with sewage farming if they believed that those living in the neighbourhood of the farms would be affected injuriously in their health, or if they believed that, rom eating the produce of sewage farms, they were liable to be attacked by enteric diseases, or by parasitic worms. He could find no fact at all in the paper of Dr. Tidy more recent

than 15 years ago, and he should like to know if Dr. Tidy had not been able to acquire any new facts as to the bad influence upon the health of those living in the neighbourhood of sewage farms. He would go over the evidence that had been adduced very shortly. He had said that the sewage farm on the Craigentinny meadows had had a bad effect upon the health of the neighbouring population; but he did not add a very important fact, as told by the Medical Officer of Edinburgh, that there was no injurious effect on the health of the soldiers living in the adjacent barracks. When the cholera was raging in Edinburgh in 1875 and 1876, there was not a single case of cholera at the Kelso Barracks. As regards the most important case contained in Dr. Clouston's evidence, to the effect that an outbreak of dysentery in Cumberland and Westmoreland Asylum had resulted from the sewage farming operations, it certainly appeared from Dr. Tidy's paper that there had been a severe attack of dysentery, which was directly caused by the smells from the land irrigated by sewage. He had looked at the *Medical Times and Gazette* for 1865, in which that case was reported, and there was no doubt that the sewage was first of all allowed to flow into a tank, and the overflow was taken on to the land to be irrigated. In his opinion the sewage would have undergone decomposition and putrefaction in the tank, and that when it got upon the land it was in a very stale condition. The land was described as not being laid out in a scientific manner, the under-drains were choked up with sand, and there was liquid irrigation on the surface of the land, so that if dysentery arose from the bad smells, as he had no doubt it did, it was because the sewage was putrid, and because the land was in such a bad condition that it was really nothing more than a stinking marsh. Amongst the other cases, there was not one in which disease had been attributed to a sewage farm conducted on proper principles. In every case of disease he had found that the soil was sodden sewage, or something of that sort, sufficient to indicate that the sewage farm was not conducted on proper principles. If there was no evidence to indicate that disease arose from sewage farms, on recent data, they had very favourable evidence. The report of the judges of the sewage farm competition of 1879 found that the average rate of mortality on nine sewage farms did not exceed three per 1,000 per annum. That was a very low rate indeed. Then the results of the sanitary inquiry issued on sewage farming, showed that it was not detrimental to life or to health. Dr. Buchanan, in 1870, had said that the health of the children in the irrigated district was much improved. The report of the British Association Sewage Committee, in 1873, which was arrived at after a study of all the aspects of the sewage question, showed that the committee came to the conclusion that in no instance had any disease whatever been traced among the labourers on the farms, or among the inhabitants in the vicinity, or among the cattle. As to the question of entozoa, Dr. Tidy had endorsed Dr. Cobbold's views, but he did not believe that there had been any fact brought forward about the spread of parasitic disease from sewage farms. The British Association Sewage Committee came to the conclusion that there were no facts in support of Dr. Cobbold's views, and that the sewage killed the parasitic larvæ. If the sewage killed them, they could not possibly develop, and that disposed of the matter once for all. Those who supported the entozoa theory, had still to prove that the ova of tape and other worms were able to exist in sewage at all. Sewage was generally an alkaline fluid, and the *habitat* of worm in the intestines was an acid fluid. It had yet to be proved that the ova of tape worms could exist for any length of time in alkaline fluid. Referring to the remarks of Mr. Bailey Denton on sewage farms in frost, he believed that the American experience bore out that gentleman's views. Beyond the scientific question, there was a social aspect. They heard now-a-days about the agricultural depression and the decay of British farming, as well as of providing work for the unemployed. It seemed to him that they could be doing two things at once if local authorities, which were now, in many cases, starting large public works for the relief of the unemployed, would try and purify their sewage better, by laying out sewage farms, for not only could they thus help the unemployed, but they would be doing something to revive British farming, and, as Dr. Carpenter had said, if in time of war they ran short of supplies, sewage farming would do something to supply food for the million.

The CHAIRMAN regretted that Sir Frederick Abel's engagements prevented him from presiding on that occasion. He considered that there was no more important questions to the community than that of the disposal of sewage, and of how to get rid of their refuse without doing any injury. The question of sewage disposal was every day assuming larger importance, because the population was continually increasing, and increasing on a very limited area, which intensified the evils. It was that which had caused this question to assume so much importance. Of course, if every town was constructed upon the principles of that city which Dr. Richardson had so well described—a sort of Utopia—they might then be able to arrange the sewers, and the drains, and the disposal of the refuse, so as to suit the broad irrigation principles; but there were many towns and places where the system could not be applied, and they must adopt in different places different methods of treatment suited to the locality, and the proximity of population, and to various other conditions which governed the matter. Therefore, he thought they could not but feel grateful to those persons who brought this subject before them in the very able way in which Dr. Tidy had done. No doubt there were many who differed from

him on various points, but he thought they would all agree that he had treated the subject in a very careful and exhaustive manner, and that the thanks of the Society were most eminently due to him for his paper.

Dr. TIDY, in replying, said it was not at all astonishing that a discussion on sewage, lasting over many nights separated at long intervals from each other, should have become somewhat discursive. He was anxious to recall the members of the Society to the main facts that he had brought before them in his paper. He wanted to carry them away from the social questions to the great question of the treatment of sewage. The real question was, they had the sewage to deal with—what could they do with it? The first thing that occurred to him, and which he specially mentioned in his remarks to the Society, was that that they should get rid of it, if they could, altogether. If they could turn it into the sea, by all means turn it into the sea. Nature would make use of it, and nothing would be lost. That was the cheapest and the best way; but of course that was not always possible, and then the question came before them again, what they should do with it? Given a small town, the first idea that would occur to him was irrigation. He had admitted in his paper, and he did not think anybody could have been fairer on the subject than he had been, that a better effluent could be obtained by irrigation processes than by precipitation processes; but what was wanted was not simply a process which could produce a good effluent, but one which would produce a continuously good effluent. He admitted that they could get a better effluent from the precipitation process, but he pointed out that the character of the effluent in the irrigation process was not always the same on successive days. He preferred a good second-class effluent given continuously, to a process that would give even a better effluent than that which was yielded by the irrigation process, but upon the continuance of which they could not rely. He fully admitted the value of irrigation as a definite process of dealing with sewage, but there were difficulties in irrigation under certain conditions, and he wanted to make it quite clear that he had pointed out those difficulties. Irrigation would deal with excreta and such like, but how about the manufacturing refuse? Of course, Major Flower might say, "Keep that out," and he hoped that Major Flower would succeed in educating the people in keeping it out, but it was in the sewers at the present time, and they must discuss the question from the position in which they found it. They must remember that all the arguments that had been brought forward on this question of irrigation had reference to sewage that might be called domestic sewage, and not to sewage that was manufactured. Then he had brought forward in his paper the depreciation of ground, and would refer to the subject again. He had also brought forward the questions of frost, of water-logging, and of the difficulties of getting ground, for his friend, Sir Robert Rawlinson, had rightly said (in other words) that there was the least ground where there was the most sewage. Then there were the difficulties of management. He had said elsewhere that sewage was no Sabbatarian, but that it came on Sundays as well as on week-days; in frost, in summer, and in winter. He had said that those were all difficulties which might be met with at certain places, and that though irrigation might be regarded as one process, it was a process which was clearly not the only process, and that they were compelled to think of other processes. He was not an opponent to irrigation—very far from it—but he tried to see what was the real place of irrigation in sewage treatment. Turning to the precipitation of sewage, he found that there was a process which could deal with the manufacturing refuse, a process that, at any rate, was independent of meteorological conditions, and a process where they had not the same difficulties of ground, although there must be some difficulties of ground; and, lastly, it was a process more under control. He admitted the difficulties, because he had put before them the fact that, although the effluent from the precipitation process was not so good as the best effluent from the irrigation process, he had said that there were enormous difficulties with the sludge that was produced, and he thought it might be taken that he had put those things fairly before them. He had said that some of those difficulties had been met, and that the effluent could be improved by a combined process. There would be no blocking of the ground, because all the *papier maché* material would be taken out. He had pointed out that even the meteorological conditions would assist. He had put all those things together, and endeavoured to arrive at a conclusion. He was not there to support one system or the other; he had no patent; he never had been the author of a Bill. He admitted that precipitation alone was a good system, if they did not want very great purity; but the best result, he maintained, was a combined process. That was his story, which, as a chemist, he would venture to call a molecular story. As the molecules were made up of many atoms, so this story had been made up of many conditions. Referring to the questions that had been touched upon in the discussion, he said that some had been prominently brought forward which he neither directly nor indirectly referred to in his paper, and which were purposely omitted by him. As to the A B C company's sludge, which Professor Dewar and himself examined with very great care, they had, in their report, expressed no opinion on the value of that sludge. They said, as to the manurial value of the native guano, they were strongly of opinion that this must be judged rather by the practical results of the agriculturist than by presumed theoretical values, based on analytical data, and on the price of ingredients

not necessarily in the same physical or chemical condition. Recent research tended to show that the very small changes brought about in soils may have very important indirect results. His own conviction of the value of the manure was that chemical analysis could only give a theoretical value that had no relationship necessarily to the agricultural value. When Mr. Birch spoke of this, and attacked him on the A B C process, he talked about the absurd value put upon the sludge; another person said the value was enormously too high; and when Sir Robert Rawlinson referred to it, he talked about the extravagant price asked for it. He would grant all that; but, in justice, he must state the fact that the A B C company could sell all the manure they made; that when people had bought it once they came again for it, and unless it was contradicted, which it never had been, they got £3 10s. a ton for everything they sold. He did not say it was worth £3 10s., and he would go so far as to say that it would not alter his argument one single iota if it had no value at all, or if it had less than no value. Another matter referred to was that of the metropolitan sewage. He had kept this out of his paper because he did not want to discuss individual cases. Dr. Dupré introduced the subject, it was taken up by Mr. Dibdin, it had been fought out over and over again, and he had read about 150 letters to himself, complimentary and otherwise, on the subject, within the last few months. He was charged with having shirked the question, but he did not wish to shirk it at all. The report of the chemist to the Metropolitan Board of Works was signed by four gentlemen. Those gentlemen were Dr. Williamson, Dr. Odling, Sir Frederick Abel, Dr. Dupré, and, out of fairness, he thought he must add Mr. Dibdin. He earnestly asked the attention of the Society to the views of those gentlemen before the Royal Commission. Taking Mr. Dibdin first. He was asked about the analyses. "The various analyses," he said, "which had been made on the Thames water show that the organic ammonia yielded by samples collected above Teddington Weir is only half to one-third of that in samples taken at Woolwich, so if we deduct the additional quantity of organic matter which the river receives in its downward course through the ships, it will be at once seen if the water at Woolwich and other points in the neighbourhood of the outfalls is contaminated by the Board's sewage works, it can only be to a trifling extent—an extent not greater than that present in ordinary London drinking water." In another passage even more definite, Mr. Dibdin said:—"Analysis shows at first sight that the river is not polluted with sewage or anything to such an extent as to cause a nuisance; and, independently of chemical analysis, common observation shows the same thing." Dr. Dupré was a little more definite, as he usually was. He said, before Lord Bramwell's Commission:—"The analyses show that the river is quite capable of dealing with the amount of sewage discharged into it without ever getting generally into a bad condition; and they show also that the amount of the sewage daily discharged is, upon the average, daily got rid of, otherwise there would be a progressive increase in the pollution which we have not observed. That, I think, clearly shows that the river is quite capable of disposing of the sewage which is discharged into it." Again, he said, in answer to the question, "Could you upon those occasions perceive any offensive smell upon the occasions of your visits?" "No; we had always a large bottle with us, and took samples repeatedly going up and down the river, shaking up the bottle to smell the water, and I repeatedly got into a small boat, and got into the spray of the screw of the steamer, and outside the sewage stream, I never smelt the river in any way to be offensive. The smell is very much the same really from Teddington downwards. It has a peculiar musty odour, like wet straw." Sir Frederick Abel said, in answer to the question, "Have you experienced any annoyance from the river?" "No, I have not. I may state that a walk upon the river wall, or a breath of fresh air upon the 'T' pier of the Arsenal in the evening, had been very often my only chance of getting anything like recreation and fresh air, and I have never upon any occasion experienced the least annoyance or inconvenience from the river at that spot." In another portion of his evidence he said, "I have carefully examined the analytical results which have been collected, and the experiments made on both sides, and I fail to see any evidence of the increasing pollution of the river. On the contrary, I feel confident that it has been well established that the river is competent to deal with the amount of impurity discharged into it, and that the purifying power is at the present time in excess of the polluting influence." In another quotation he said, "I consider that, as far as one is enabled to draw a fair conclusion from facts, a much greater degree of pollution may be satisfactorily dealt with, as far as the river is concerned, in the way in which it is dealt with now." Dr. Odling was then asked, "You have heard the evidence given by Dr. Dupré and Sir Frederick Abel, have you not?" "Yes, and I entirely agree in what they have said." "What do you say with respect to the self-purifying power of the river?" "I say in particular that I quite agree with what Professor Abel has said, that the self-purifying power of the river is in excess of the polluting action of the sewage discharged into it, so that even the worst stretch of the river water oscillating above and below the outfalls does not get so polluted as to create a nuisance." Then he was asked, "How do you consider that fact has been established?" "I consider that fact has been established both by ordinary observation of the river, that as a body of water it does not smell offensively, or look offensively; that there is no evidence to the senses that it is polluted: secondly, that when we come to examine it by analytical methods, we find there is no definite body of polluted water which

may be distinguished from the general mass of river water; that, starting from Teddington, there is a continual gradual increase of pollution until you get to the outfalls, and then a gradual decrease of pollution until you get to the mouth." Those were the opinions of gentlemen who signed the report—that there was no nuisance, no pollution; no need to do anything. He would not discuss the details of their report, for instance, the 3·75 grains of lime. It was a curious number, and he could not make out at first how they arrived at it, but he thought he understood it now. 3·75 grains was the quarter of 15, and 15 grains to the gallon made a ton to a million gallons. One grain of sulphate of iron, again, was a curious number; of course it meant nothing. Dr. Dupré was quite clear about that. He would read another quotation from Dr. Duprê. There was a case a short time time ago, in which he (Dr. Tidy) proposed a method of chemical treatment, and he suggested that there should be used five grains or a little more of lime, and rather more than five grains of sulphate of alumina, with a little iron. Dr. Duprê gave evidence against the scheme, and he would read a passage or two from that evidence. He there stated that he understood the sewage was to be treated with a certain proportion of lime, about five grains per gallon, not to be added in solution, but as milk of lime; then the sewage was to be stirred and allowed a short rest. After that there was to be run into it a solution of alum in a certain proportion, about five grains per gallon. Then there was to be some sulphate of iron added, and it was to rest for three hours and be syphoned off, and then Dr. Dupré was asked:—"What do you say will be the result?" A.—"The result will be a very bad effluent." Then he was asked on what he based that opinion, and he said he had experimented in a moderate sized vessel on several gallons, and continued, "I think, as far as I understand the process proposed, it will not produce a good effluent, because the amount of chemicals proposed to be used is much too small." Then he was asked if double the quantity would be enough, and he said, "No doubt double would not be enough." Q.—"Would three times be enough." A.—"Three times might probably be enough." "Then," said Mr. Michael, who was examining him, "assuming that there is three times the quantity used, so as to have the maximum beneficial effect," but then Dr. Dupré said "that would have by no means the maximum beneficial effect; you would have to use 20 to 50 times the quantity." And now for the question of sewage farms. Dr. Carpenter had admitted there were great difficulties, but he had attributed them to management by committees, usually of gentlemen connected with the local authority, who were not in any way scientific men, and so on. The question of frost had been referred to, and on that point he would take the evidence of an ardent irrigationist—Dr. Frankland. He said, speaking of the Croydon farm, "It must be noted, however, that during the continuance of the seven nights' frost, in January, 1869, the purification here, as at Norwood, became markedly impaired, the organic nitrogen increasing enormously. The assimilation of the ammonia by the vegetation was also retarded, as is seen from the increased quantity of ammonia in the effluent water. Unfortunately, the winter of 1868-69 was too mild to permit of this point being satisfactorily tested; and it would therefore be desirable to resume these experiments during a longer frost." Colonel Jones had said something practically to the same effect, for he admitted there were difficulties in times of frost. He did not well see how it could be otherwise. Again, with regard to the question of water-logging. Dr. Carpenter said any farm which was allowed to get water-logged was badly managed, and of course it was. That was what he complained of — bad management, which seemed always to follow sewage farms. He did not wish to say too much about the Croydon sewage farm, but he might refer to it at great length if it were necessary. Dr. Carpenter hit the real blot when he referred to the likelihood of accidents in a sewage farm. He said if irrigation was carried on properly there would be none of these objections, which no doubt did arise when it was not carried on in the proper way. If everything were done properly, and if there were proper land, a proper system, and proper men to look after it, possibly things would go on well enough; but that was not the way to deal with sewage. Then Dr. Carpenter went on to say that the sewage should be taken out of the hands of a local authority, and he referred to the wages paid for superintendence, and said you could not expect a man to do his duty and prevent smells at 30s., but all would be right if you paid £3 a week. Dr. Carpenter said that when they had had five or six acres under sewage irrigation, there were times again and again when there was no smell whatever, but there were other times when the manager, who was paid 30s. or £2 a week for looking after this immense area, had failed in his duty, and had allowed smells to arise. The whole thing depended upon whether you paid a man 30s. or £3, or whether you left the management in the hands of the local authority or not. That was the fair conclusion to be drawn from his remarks. Supposing you put the farm under conditions which prevented anything going wrong, of course it would not go wrong; he only said the conditions were such that it was almost inevitable that it should go wrong. Dr. Carpenter might ask him to mention a place where frost and water-logging had occurred. He could mention such cases, but he was not going to. It was much easier to tell a number of people gathered together at a meeting of successes than to speak of failures, but he begged leave to remind them that Barnet, Croydon Rural, and Wimbledon farms were at the present time under injunction. Of course the Croydon Urban was perfect under Dr. Carpenter's management. He knew nothing could be better! There was no pollution of the Wandle whatever; but

would Dr. Carpenter be surprised to hear that there were some wicked people who thought otherwise, and that he might hear something more of their views some day? Perhaps somebody would have to say something about it somewhere else than at the Society of Arts. But at any rate, says Dr. Carpenter, you get a good effluent, and there was no nuisance, and if anybody said there was, he said what was not true. But he (Dr. Tidy) knew Beddington Farm very well. Not long ago he went over it in company with an eminent barrister, and if Dr. Carpenter said there was no nuisance from that farm, he begged to differ in opinion from him. He saw with his own eyes masses of fæcal matter all over the farm drying and festering. The late Mr. Smee, a few years before his death, who had a garden in the locality of Beddington Farm, spoke of the smell from that farm as quite sickening. Then Dr. Carpenter said what Dr. Creasy said had been withdrawn, and someone else asked, where did Dr. Creasy say anything about it? He said it before a Parliamentary committee; and, in fact, used very strong language about the evil effects of that Beddington Farm. Had Dr. Clouston withdrawn his opinion? The Craigentinny meadows belonged to the city of Edinburgh, and, therefore, however strongly he might agree with the views of a medical officer of health who was a servant of the corporation, he liked to have independent authorities as well; and Dr. Clouston had never withdrawn a word he had said about it. Of course, he admitted there had been a great deal of exaggeration in what had been said. It was no use telling him that the complaints were mere sentimental grievances—admitting that nine-tenths were such, that was not the point. There were, and had been in many cases, a very definite nuisance, and he could state that from his own actual experience. But, said Dr. Carpenter, whenever there were offensive smells from a sewage farm, the people who were managing it failed to do their duty; there ought not to be any kind of offensive smells, and he said when they had under irrigation 500 or 600 acres, he found at certain times no smell which could be noticed by anybody. The inference was, there were times when there was a smell; that was the only conclusion you could draw. But, said Dr. Carpenter, at any rate they got money out of it, whilst from precipitation schemes you got nothing at all; and there was a long story about the cows and the milk. Now, he was not going to discuss money views; but the curious question about these farms was how certain items were always omitted from the account, such as interest on borrowed money, the cost of superintendence, and a few little things of that sort. He happened to know what to look for in these accounts, and knew what was missing. The Croydon people started the growing of market produce, and they proposed to pay all the rates out of the sewage farm. But they gave up growing market produce, and he would say why in his opinion they did so. Many years ago, there was a discussion on sewage at the Health Officers' Association. Dr. Carpenter was there, and he brought with him some magnificent heads of celery, as specimens of what could be grown on a sewage farm—the finest he had ever seen, he should think they were five feet high; and Dr. Carpenter was good enough to present him with one of those heads of celery. He took it home, thinking it would be an excellent accompaniment to his modest mid-day meal on the Sunday; but he was much disappointed to find by mid-day on Sunday that that head of celery had all gone rotten. Why did they give up garden produce? He was very much tempted to ask the question whether they could ever succeed in getting it to market. Then, said Dr. Carpenter, "Let us fall back on milk and beef;" and he gave quite a glowing description of the magnificent herd of cows they had; but he told them there were great difficulties in the sale of the milk. There was great prejudice. It was necessary not to let people know that it came from the sewage farm—they had to keep it dark. Then Dr. Carpenter came on the scene, and he went round amongst his friends and induced them to take the milk by offering it to them at 30 to 40 per cent. below the market price. He could not help asking himself the question, supposing there had been no Dr. Carpenter, nobody with a large retinue of friends and the power of inducing those friends to take the milk at 40 per cent. less than market price, how would it have been disposed of? Sir Robert Rawlinson said the milk was of good quality, and he did not deny it; he had never said anything to the opposite. Dr. Carpenter had referred to something he had said, but all he said was not that it would turn sour, but that a case came before the Courts in which it was suggested that the milk of cows fed on sewage grass was more apt to become sour than that from cows not so fed, and he could give the details of the case if necessary. Then Dr. Carpenter said that at any rate he was wrong about Dr. Cobbold. Probably no one understood parasitic disease in England so well as Dr. Cobbold, who was an elaborate worker, a careful thinker, and a decidedly intelligent observer. He (Dr. Tidy) had quoted Dr. Cobbold's own printed words, but Dr. Carpenter said he had in his possession a letter in which he informed him that he was quite mistaken in regard to the results he had then come to. Now he (Dr. Tidy) knew exactly how much Dr. Cobbold withdrew, for he had a long talk with him not long before his death. He had given an opinion that certain ova might be drawn up into the body of plants, and so get absolutely into the plant itself, and be the means of producing disease, and he said that he believed in that respect he had been mistaken; but as regarded the other fact, of a quantity of sewage manure being drawn up the stalk of the plants, and sticking there, and that being eaten by animals or by human beings, he never did withdraw that. He should have liked to ask Dr. Carpenter about the pollution of the chalk wells in Croydon, but he would not stay to do so.

Just a word or two on some other points which had been mentioned. Mr. Birch said something about a mistake he had made with regard to the sewage of midden towns. Dr. Frankland had given a large number of analyses of sewage from midden towns and sewage from water-closet towns, and said the difference was entirely due to the difference of quantity. He would only say that it was perfectly clear that Mr. Birch was wrong. That was no explanation of the matter, but it would entail the entering into a considerable number of figures to prove this point completely, and at that late hour he would not do so. It was not a mistake on his part at all. A word about the experiments on intermittent downward filtration, which was referred to by Mr. Bailey Denton. He had admitted the power of land, and could not do any more. The principle of intermittent downward filtration draining, six feet deep, had its birth in Dr. Frankland's laboratory. The experiments were conducted in several ways, some of them in tubes six feet long. But this question of six feet deep drainage presupposed that the power of the earth was the same at each foot of depth all the way down. No doubt these tubes of Dr. Frankland were filled with surface earth; he did not suppose Dr. Frankland obtained a section six feet deep, which would give a totally different result. Recent experiments had shown that so far as purifying power was concerned, it lay almost entirely in the first 18 inches or two feet; that was practically the limit, therefore there was no use, so far as the mere taking out of suspended matter was concerned, in carrying the drainage farther down than 18 inches or two feet. Dr. Frankland had himself admitted this in a letter to *The Times* on the sewage of London, though he was really the originator and apostle of the system of six-feet drainage. In the last letter he wrote on the subject he said, "Recent investigations have demonstrated that the purifying action takes place near the surface of the land, and it is, therefore, not necessary, as was supposed during the existence of the two Commissions above mentioned, to drain the soil six feet deep; a discharge two feet deep below the surface being amply sufficient." The pail system was an abomination, and one which he had not advocated further than this, that there were places where he could imagine the system would be of great use in disposing of the sewage. He wished it to be distinctly understood that he did not for a moment advocate the pail system. He could not agree with all the remarks of Sir Robert Rawlinson, nor would the time at his disposal allow o dealing in detail with the figures which had been quoted. In the lengthy paper which he had brought forward, he had tried to deal with the subject fairly, having looked up everything which had been written upon the subject, and carefully studied the evidence given before the different Commissions. He had been professionally connected with a great number of sewage cases, not in the position of judge, as Sir Robert Rawlinson had been, but he had been behind the scenes, so to speak; and he wished distinctly to say that, in doing the work which he had done in connection with the question of sewage, he was perfectly prepared to have abandoned any views he had if the facts seemed to be against him. That he was an imperfect authority to deal with the question he quite admitted, and he could have wished that the amount of labour which he had bestowed upon the subject had been devoted to it by someone else. An object of lofty pursuit, though impossible of attainment, was not altogether unworthy of the ambition of a man of science. Though he might not be able to scale the summit of the volcano cone, he might yet reach its heaving flanks, and study the lava of the fires and the products of the fires. In like manner, though he had perhaps egregiously failed in doing all that he ought, still he ventured to think he had taken a broad view of a subject which could only be regarded from a broad view, if they would regard it accurately. As to any feeling of animosity against irrigation, he absolutely denied it. He emphatically denied that his object had been to put down irrigation and set up precipitation. The subject was one not to be treated as a question of advocacy. It was a greater question than that; it was one where they should all meet together, with one heart and one soul, to try and solve one of the knottiest problems that had ever come before scientific men, and where they must all be determined to drop peculiarities and hobbies, with the one single determination of meeting the common needs of a common humanity, and the demands of an advancing civilisation.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Dr. Tidy for his interesting and valuable paper.

Mr. FRANCIS FULLER writes, recommending the continuation of the main sewers on both sides of the river to the sea, and fitting them at intervals with means for obtaining supplies of sewage for irrigation purposes.

Mr. PEREGRINE BIRCH writes in support of his former statement as to the value of the product of the A.B.C. process.

Miscellaneous.

THE PROGRESS OF OSTRICH FARMING.

By P. L. SIMMONDS.

The Cape Colony, as it was the first to domesticate the ostrich, has hitherto had a practical monopoly of the industry. But in 1878, several shipments of ostriches took place to South Australia, New Zealand, the Argentine Republic, and California; and the Cape Parliament, taking the alarm that the colony

was in danger of losing its lucrative monopoly, imposed a prohibitive duty of £100 per bird, and £5 for every ostrich egg, on this exportation. The large order by Californian speculators for 200 pairs of ostriches naturally alarmed the South Africans.

So incessant was the hunt of this bird for its feathers that, up to 1864, it was commonly thought that the day was not far distant when the ostrich would be numbered among the extinct birds of the world, such as the moa and dodo; but in the year 1865 some eighty ostriches were domesticated. The export of feathers, nearly all from wild birds, in that year, was 17,522 lbs. weight, valued at £65,730. Since then the industry has progressed by artificial hatching and care of the birds, and it is now estimated that there are about 150,000 domesticated ostriches living at the Cape Colony, giving employment to not less than eight millions of capital. The highest export of feathers was reached in 1882, when 253,954 lbs. weight were shipped, valued at £1,039,989. The shipments for 1885 were nearly as large—251,084 lbs.—but the total value had dropped considerably, being only £585,278.

The price of feathers varies from two shillings a pound for "dark chicks," to very many pounds for "prime whites." If, however, we average all kinds, we find a singular variation in prices, as the following figures will show:—

	Per pound.				Per pound.		
1850	£3	13	0	1870	£3	1	0
1855	6	0	0	1875	6	3	0
1860	8	8	0	1880	5	8	0
1865	3	14	0	1885	2	6	0

This heavy fall in prices shows that, to some extent, production has exceeded demand.

One of the chief attractions in the Cape Court of the Exhibition just closed, after the diamond-cutting, was certainly the magnificent show of ostrich feathers.

In the adjoining colony of Natal the result of ostrich farming cannot, as yet, be said to be a settled success. The coast does not appear to be well adapted for this enterprise. There is a county ostrich farming company at Pietermaritzburg. The export of feathers, derived chiefly from beyond the borders of the colony, for the past five years has averaged over £13,000 per annum. Experiments inland are somewhat more encouraging for rearing, and in many parts of the Transvaal birds have done well. There are no accounts available of any successful progress made in California, the River Plate, or South Australia; but from New Zealand a first consignment of ostrich feathers has just come to hand by the steamer *Rimutaka*. Mr. John J. Matson, of Springfield, Papanni, Christchurch, has succeeded in acclimatising and rearing the birds, and his first shipment is 2,000 feathers of rare beauty. Persons who professed to know the habits and nature of the ostrich, warned Mr. Matson that his venture was sure to fail, that the birds would not mate there, that the hens would not lay eggs, that the eggs would not be hatched, and that if young were hatched, it would only be to die long before arriving at matuiity. Nothing daunted by these warnings, Mr. Matson persevered with his experiment, and, being sole New Zealand owner of ostriches, he is about to reap some return for his efforts.

COLONIAL WINES.

By Richard Bannister, F.I.C., F.C.S.

(*Continued from p.* 53.)

The names given to the wines produced are various. In some cases they are named after European types, in others they are called by the names of the grapes from which they are made, and a considerable number have double names, the first being the name of the vineyard and the second that of the wine. A comparison of those named after European types with the types themselves will show that soil, climate, and other conditions not common to the two, have stamped the Australian wines with an individuality which can never render them exact substitutes, and the comparison will, I think, show that the lighter qualities of Australian wines are admirably suited for consumption in this country, when the commoner wines of France might be found too cold and thin for ordinary use. It will require a little education on the part of the public to enable them to understand what descriptions of wine are represented by the names of the grape producing them, but as the wines are rising in public estimation, a little intimacy with their peculiarities and qualities will do much to familiarise us with the new wine nomenclature, and thus get over some of the difficulties which beset us on a first acquaintance. Amongst them will, however, be found excellent wines of each type, and without specifying those possessing most quality, it will be enough to say that the most exacting may find wines among them suited to their tastes and requirements. The calamities which have overtaken the French wine grower from the ravages of the phylloxera and the inclemency of the weather during recent vintages have, to a certain extent, been the means of familiarising the public with the stouter wines of Australia. Owing to short supplies of French wines, and to the poverty of the lower qualities of claret, it has been necessary to import into Bordeaux the stouter wines of Spain, Italy, and Cyprus, to mix them with those of native growth. These mixed wines have of recent years been imported into this country in large quantities, and their character and flavour compare more closely with Australian clarets than if not so mixed.

What the future of the French wine industry may be it is difficult to say. A recent writer in the *Figaro* estimates the losses from the phylloxera at £800,000,000, aud every year this pest continues to extend its ravages. No remedy has yet been found which will effectually destroy the insect, and if something be not soon done the vineyards in certain districts will be entirely destroyed. In Australia the

phylloxera was discovered in 1877, but the drastic measures at once put in motion by the authorities will show very clearly the amount of energy and resource at the command of our colonists. Vineyard inspectors were at once appointed, and the Chief Secretary was empowered to destroy the vines or otherwise, without compensation to the owner. In 1878, thirteen vineyards were uprooted and the ines burnt, and in 1879 six vineyards were similarly treated, all of them being situate in the Geelong district. In 1881, the "Geelong District Vine Disease Act" was passed, which gave the authorities power to uproot and burn any infected vines, to proclaim any district and put it in quarantine where the phylloxera was found, to prohibit any person, under a penalty of £100 or six months' imprisonment, from removing from a "vine disease district" any vine or part of a vine; and at an Intercolonial Conference, held in Melbourne, in December, 1880, it was agreed by the Colonies of New South Wales, South Australia, and Victoria to contribute jointly to the expense of eradicating the disease. Compensation is now granted to the owners of diseased vines to the value of one year's crop, and to owners of vines not diseased in the proclaimed districts up to the value of three years' crop. The evil was thus checked very soon after its appearance, and as it seems to be now under control, there is reason to believe that as soon as the rootlets of the uprooted vines left in the ground are dead, the pest which has caused all the mischief will die also. In a country of small peasant proprietors where the phylloxera attack has become general, such severe treatment could not be applied, consequently the outlook for the French viticulturists is gloomy indeed.

The progress of vine culture at the Cape of Good Hope has not given satisfaction to those engaged in it. Experience has proved that the quantity of wine which can be produced per acre is immense, the vineyards in the western part of the colony being capable of producing about nine times as much wine per acre as in France, and four times more than in Australia. The abundance of the crop seems to have led the proprietors of the vineyards to carelessness in the treatment of the grapes, and to indifference as to the quality of the wine made. As a consequence the quantity of wine exported has greatly diminished, the number of gallons shipped last year having been 92,000, as against 195,000 in 1865. The decadence of the exports has directed the attention of the Government to this neglected branch of industry, and active measures are now being taken to revive it on a broad and sure foundation. A vineyard has been purchased for experimental purposes, and a German expert has been engaged to take charge of it. The best vines and the most approved methods of cultivation have been introduced, and it is expected that in time the wine industry of the Cape will occupy a better position than it has ever yet done. Care and attention seem only to be necessary for changing the aspect of affairs, and as these are being given, success must be the outcome of the movement. Specimens of Cape wine received commendation at the Health Exhibition, and some of the samples exhibited this year do not fall behind them in quality. The Constantia wine has, from its first introduction into this country, enjoyed a good reputation, and it is pleasant to record that, even during the gloomy period referred to, the quantity exported has steadily increased.

The wines of Cyprus exhibited are of considerable interest, and particularly so on account of the antiquity of the wine industry. From time immemorial wine has been produced from grapes of rich quality, but the quantity of saccharine matter in them has been increased by allowing the grapes to hang on the vines till they are shrivelled, and thus deprived of a portion of water. The fermentation of the grapes was, till recently, carried on in jars of earthenware, which had been besmeared with tar. The flavour of the tar was, as a matter of course, imparted to the wine, and though it might not be objectionable to those used to it, it confined the consumption of the wine to circumscribed localities. Of late years the wine has been fermented in casks, and made on modern principles. The quantity exported in 1884 is said to have reached a million and a half gallons. The common black ordinary wine is as astringent as port with a Burgundy character. It lends itself to mixing with poorer wines grown in colder latitudes, and it is said to be extensively used for this purpose. It could be sold in this country, duty paid, at about seven shillings a dozen.

There are a few samples of wines exhibited in the Canadian court. It has been said that Nature has marked out Canada for the home of the grape; but, however, true this may be, it is only within the last few years that much attention has been bestowed upon grape culture and wine making. In 1881, four million pounds weight of grapes were raised in the Dominion, of which nine-tenths were grown in the province of Ontario. The specimens of wine exhibited possess European names, and though they differ in flavour from the wines they are supposed to represent, they are sound and pleasant, and enjoy a local reputation. The production of wine in Canada was scarcely known outside the Dominion before this Exhibition, but the knowledge thus acquired is another proof of the value of exhibitions, and of the advantage of bringing under our notice and observation the productions of other countries.

The capabilities of our colonies for wine production have necessarily been very hurriedly passed under review, but from the numerous descriptions of sound wine exhibited, and the progress made in viticulture, it is not unreasonable to expect that the hold the wines have taken upon the public taste will be maintained, and that at no distant date the mother country will draw a larger proportion of her supplies of wine from her own colonies. The incidence of the new wine duties will prove of great benefit to the

class of colonial wines, as many of them on which a duty of half-a-crown a gallon was levied will now be imported at the shilling duty, and this difference in the rate of duty represents a gain to the consumer of three shillings a dozen. With care, attention, and patience, a bright future is in store for colonial wines, the past has shown what can be done by men determined to succeed, and it is not likely that now success has been fairly assured any mistake will be made which might bring the wines into disrepute, and thus deprive the producer of his legitimate reward.

MEDICINES OF CENTRAL AFRICA.

The knowledge of drugs among the inhabitants of Central Africa is, of course, very meagre. The bright green leaves of a climbing passion flower (*Adenia venenate*), found in the islands of the Meshera, are applied for vesicating purposes; they are poisonous, however, and are said to have proved fatal to camels.

A curious application of the tar obtained from the fruit of the colocynth is made by the people on the Upper Nile. The fruit is heated in an earthen vessel with a hole in it; the tar drips through to another vessel, and is used for smearing leather water-bags. The bad smell of the tar prevents camels from cutting open the water-bags.

The Wazamaro use an arrow poison of bright red colour, prepared from the giant Euphorbia, and are said to possess an antidote to it. Many African tribes hold salt to be a bad substitute for salt water.

All along the Upper Nile tobacco is indigenous, and is prepared in different ways by the natives, each tribe having its peculiar method. In Uganda tobacco is largely cultivated, and of superior quality, resembling the "Perigne" of Louisiana.

The Wanguru grow tobacco extensively, and have three native medicines peculiar to themselves—*udaha*, the seed-pod of the *mdaha*, which when ground is very hot to the palate; and two vegetable seed-fats called *mkanya* and *kwemi*.

In the plain of the river Lualaba salt is obtained by cutting the grass and burning it; the ashes are thrown into small pans with water. The Masai mix salt and saltpetre with their snuff, but apparently never take it with food.

Correspondence.

Major-General Webber requests that the following corrections may be made in his paper on "Glow Lamps," *Journal* of December 10th, page 60:—Instead of "no further precautions are necessary," read *no further precautions to prevent arcing are really necessary.* Instead of "which unreasoningly insulates the wire which need not be in a state of electrical tension, as well as that which is always ready to discharge," read *which unreasoningly insulates that conductor which need not be in the same state of electrical tension as that which is always ready to discharge into it.*

Notes on Books.

The Conversion of Heat into Work. By William Anderson. Whittaker and Co.

Mr. William Anderson has reprinted in the form of a text-book, forming one of the Specialist Series published by Messrs. Whittaker, the Howard Lectures he delivered at the Society of Arts during the Session of 1884-5. The lectures have been a good deal enlarged, and several illustrations have been added, besides those which appeared when the lectures were published in the Society of Arts' *Journal.*

Lives of the Electricians. First Series. By William T. Jeans. Whittaker and Co.

In this work, which is announced as the first series, Mr. Jeans has included lives of Dr. Tyndall, Sir Charles Wheatstone, and Professor Morse. In the first memoir, certain elementary principles of magnetum, electricity and co-relative forces are explained, in the second is a notice of some of the methods by which such scientific principles were made serviceable to man, and in the third is contained an account of the labours of a life devoted to the production of a universally adopted telegraphic apparatus and alphabet. The "Lives" deal not only with the electrical work of the three men of science, but form complete biographies.

The author believes that although a large literature has grown up around the subject of electricity, the human element has been somewhat neglected, and he hopes that a series of lives of electricians will bring home to the general reader a more vivid idea of the wonders of the science. He says, his "guiding principle in the compilation of the book has been the maxim of Goethe, that the main object of biography is to exhibit man in relation to the features of his time."

Obituary.

Norman Chevers, M.D., F.R.C.S., C.I.E.—Dr. Norman Chevers, Deputy Surgeon-General H.M. Indian Army (retired), died suddenly on Thursday, 2nd inst., aged 68. He began life as a student at the then united hospitals of Guy's and St. Thomas's, and in 1848 he entered the Bengal Medical Service. He was Secretary to the Medical Board at Calcutta,

and subsequently became principal physician and professor of medicine at the Medical College of Calcutta. He was also a member of the Medical Committee appointed by the Secretary of State for India to inquire into Prof. Koch's discovery in connection with the prevalence of cholera. In 1879, the Swiney prize was awarded to Dr. Chevers for his work entitled, "A Manual of Medical Jurisprudence for India."

ARTHUR GROTE.—Mr. Grote died on the 4th inst. at his house in Ovington-square. He was a younger brother of George Grote, the historian of Greece, and was born at Beckenham, in 1814. He was educated at Haileybury College, and entered the Bengal Civil Service in 1834. He held the offices of Chairman of Revenue Board of Bengal, and President of the Royal Agricultural Society of India, and of the Asiatic Society of Bengal. On his return to England in 1868, he became a prominent member of the Linnean and Royal Asiatic Societies, and wrote many papers on Natural History subjects. Mr. Grote was elected a member of the Society of Arts in the present year.

General Notes.

GUTHRIE MEMORIAL FUND.—A Committee has been formed, under the presidency of Professor Huxley, to raise a fund for the benefit of the widow and children of the late Professor Guthrie. Subscriptions may be sent to the Honorary Treasurer, Major C. A. Macgregor, R.E., Science Schools, South Kensington Museum, London, S.W.; or to the Honorary Secretary of the Fund, Mr. C. Vernon Boys, at the same address.

REWARDS FOR WORKMEN.—By a decree of the French Government, which lately appeared, the Minister of Commerce has the power of granting medals to French workmen or *employés* who can show a consecutive service of more than thirty years in the same industrial or commercial establishment, situated upon the territory of the French Republic. A diploma is also presented on which are recorded the services for which the distinction has been granted.

BARCELONA EXHIBITION.—Further particulars respecting the International Exhibition to be held at Barcelona from September, 1887, to April, 1888, have been received since the notice printed in the *Journal* of September 3rd last (Vol. xxxiv., p. 1006). The Exhibition will be opened on the 15th September, 1887, and closed in April, unless an extension of time for two months be found desirable. The whole of the contents of the Exhibition must, however, be taken away, and the space free by the 1st July, 1888.

FACTORY LEGISLATION IN RUSSIA.—The new Russian factory law provides for a workman who has been injured by the negligence of his employer, receiving compensation. In the event of his death from such injuries, his family is entitled to claim; and if no agreement as to the sum can be come to between the parties, a tribunal decides the point. Further legislation is in preparation, but the introduction of this measure has been a direct result of the troubles in the Wladimir district. The head of any factory who has, by illegal actions, provoked disturbances, is liable to imprisonment and contingent deprivation of the right to hold such a post in future. Reduction of wages or of time of working cannot be made until the termination of existing contracts with workpeople; and when such do not exist a fortnight's notice is required. The system of fines has been remodelled upon an equal basis. A scale of punishments has been drawn up for strikes and disturbances, the maximum penalties being reserved for the intellectual promoters of strikes, while no punishment is to be inflicted upon those who only take part in strikes, and who resume work immediately upon being summoned to do so by the police authorities.

MEETINGS OF THE SOCIETY.

CANTOR LECTURES.

The First Course is on "Principles and Practice of Ornamental Design." By LEWIS FOREMAN DAY. Four Lectures.

LECTURE IV.—DECEMBER 20.— *Natural Form and Ornamental Treatment.* — Artificiality and literalism. Mistaken convention. Precedent. The help and the hindrance of nature. The persuasion of natural forms to ornamental purpose. Accident and design.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "The Principle and Practice of Ornamental Design." (Lecture IV.)
British Architects, 9, Conduit-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. Seebohm, "Birds' Nests and Eggs."

TUESDAY, DEC. 21...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Professor Alex. B. W. Kennedy, "The Use and Equipment of Engineering Laboratories."
Statistical, School of Mines Jermyn-street, S.W., 7¾ p.m. Mr. L. L. F. R. Price, "Sliding Scales and other Methods of Wage-Arrangements in the North of England."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. J. Bland Sutton, "Atavism." 2. Dr. R. von Lendenfeld, "The Systematic Position of Sponges." 3. Dr. A. Gibbs Bourne, "Indian Earthworms." 4. Mr. G. B. Howes, "The Fin of *Ceratodus*."

WEDNESDAY, DEC. 22...Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. To discuss the Patents Bill before the New South Wales Legislature.

THURSDAY, DEC. 23...London Institution, Finsbury-circus, E.C., 6 p.m. Prof. E. Ray Lankester, "The Elements of Biology." (Lecture V.)

Journal of the Society of Arts.

No. 1,779 Vol. XXXV.

FRIDAY, DECEMBER 24, 1886.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

IMPERIAL INSTITUTE.

The following is the Report of the Committee appointed by H.R.H. the Prince of Wales to prepare a scheme for the Institute:—

The Committee appointed by your Royal Highness to frame a Scheme for an Imperial Institute, intended to commemorate the fiftieth year of Her Majesty's Reign, beg leave to submit to your Royal Highness the following Report.

They do not fail to remember that the scheme which your Royal Highness indicated in your letter of the 13th of September last to the Lord Mayor of London, had its origin in the remarkable interest excited by the recent Exhibition, by which not only the material products, resources, and manufactures, but the loyal feeling of the great Colonies and Possessions of Her Majesty's Empire were illustrated in a most signal manner.

The object, therefore, which naturally suggested itself first to the Committee was the development, with some necessary modifications, of your Royal Highness's idea of creating a permanent representation of the resources and progress of the Colonies and India.

On pursuing, however, the consideration of the subject, the Committee became persuaded that a Memorial really worthy of the Jubilee Year of Her Majesty's reign could not be confined in its objects to any one part or parts of Her Majesty's Empire, and that it must, in some form and degree, also comprehend a representation of the United Kingdom.

Their desire, therefore, in the following outline of the scheme which they recommend, is to combine in a harmonious form, and with a view to some practical and useful purpose, a representation of the Colonies and India on the one hand, and of the United Kingdom on the other.

They submit that this object will be best indicated by giving to the Memorial the title of The Imperial Institute of the United Kingdom, the Colonies, and India.

They think that the Institute should find its home in buildings of such a character as worthily to commemorate the Jubilee Year of the Queen's reign, and to afford accommodation suitable for an institution combining the important objects which they now proceed to describe.

It is obvious that several departments of the Institute, such as the Hall, Conference Rooms, &c., which will be found described under the Colonial and Indian Section, and the United Kingdom Section respectively, will be common both to the Colonies and India, and to the United Kingdom; but as others have special relation to a particular portion of Her Majesty's Dominions, it will be found convenient to make the following division.

A.—Colonial and Indian Section.

The object of the Colonial and Indian Section will be to illustrate the great commercial and industrial resources of the Colonies and India, and to spread a knowledge of their progress and social condition.

To this end provision should be made for:—

1. The display in an adequate manner of the best natural and manufactured products of the Colonies and India, and, in connection with this, the circulation of typical collections throughout the United Kingdom.

2. A Hall for the discussion of Colonial and Indian subjects, and for receptions connected with the Colonies and India.

3. The formation of Colonial and Indian libraries, and establishing in connection therewith reading, news, and intelligence rooms.

4. The incorporation in some form into the proposed Institute of the Royal Colonial and Royal Asiatic Society, if, as is hoped, it be possible to bring about such a union.

5. The collection and diffusion of the fullest information in regard to the industrial and material condition of the Colonies, so as to enable intending emigrants to acquire all requisite knowledge. Such information might be advantageously supplemented by simple and practical instruction. An emigration office of this character should be in correspondence with the provincial towns, either

through the free libraries or by other means, so that information may be readily accessible to the people. These objects would be greatly facilitated if, as may be hoped, the Government should consent to the transfer to the buildings of the Institute of the recently formed Emigration Department, which would, by a close connection with the Institute, largely increase its usefulness.

Facilities might be afforded for the exhibition of works of Colonial and Indian Art.

It is also considered desirable that means should be provided, not for a general exhibition, but for occasional special exhibitions of Colonial and Indian produce and manufactures. At one time a particular Colony or portion of the Empire may desire to show its progress; at another time a general comparison of particular industries may be useful. Whilst the permanent galleries would exhibit the usual commercial or industrial products of the several Colonies and India, the occasional exhibitions would stimulate and enlist the sympathies of Colonial and Indian producers, and keep up an active co-operation with the industrial classes of this country.

B.—United Kingdom Section.

The leading objects of this Section will be to exhibit the development during Her Majesty's reign, and the present condition of the natural and manufactured products of the United Kingdom, and to afford such stimulus and knowledge as will lead to still further development, and thus increase the industrial prosperity of the country.

We submit that these objects may be carried out by making provision for the following purposes:—

1. Comprehensive collections of the natural products of the United Kingdom, and of such products of other nations as are employed in its industries, with full scientific, practical, and commercial information relating thereto.

2. Illustrations of manufactured products, typical of their development and present condition, of trades and handicrafts, and their progress during the Queen's reign, including illustrations of foreign work when necessary for comparison; together with models illustrating naval architecture, engineering, mining, and architectural works.

3. A library for industrial, commercial, and economic study, which should contain standard works and reports on all subjects of trade and commerce. It will be desirable also to include a library of inventions of the Empire, and, as far as possible, of the United States and other countries.

4. Reading and conference rooms supplied with English, Colonial, and foreign commercial and technical periodicals, and a fully-equipped map-room for geographical and geological reference. The conference rooms would be of value for meetings of Chambers of Commerce and other bodies of a kindred nature.

5. The promotion, in affiliation with the Imperial Institute, of commercial museums in the City of London and in the commercial centres of the provinces. To these the Institute would contribute specimens, samples, and exhibits of the commercial products likely to be specially valuable in particular localities. There should also be an organisation to connect the Imperial Institute with the provincial centres by lectures, conferences, the circulation of specimens, and other means.

It is hoped that the Institute may lead to the organisation of High Schools of Commerce, such as are now established in the chief commercial towns of most Continental countries, but which have, as yet, unfortunately no existence in the United Kingdom.

6. The building will also advantageously afford accommodation for (*a*) comparing and examining samples by the resources of modern science, and (*b*) the examination of artisans under the various schemes already existing for the promotion of technical education.

Space should also be provided for occasional exhibitions of separate industries, or of the special industries carried on in great provincial centres: for example, there might at one time be an exhibition of iron manufactures, at another of pottery, at another of textile fabrics, &c., which would tend to stimulate improvement in the different department of industrral life. This object might be assisted by separate exhibitions of the handiwork of artisans.

The Committee having detailed the general nature of their suggestions under these heads, desire to add that they do not anticipate the exhibits in the collections remaining unchanged. They contemplate that as improvements are made from time to time, the later and better results would displace those out of date.

They have had to consider how the space should be distributed between the United Kingdom on the one hand and the Colonies and India on the other, and they recommend that whatever portion of the buildings is not required for purposes manifestly common to

both should be allotted to the two Sections fairly in equal parts.

C.—Government of Institute.

The Committee recommend that a new body, entirely independent of any existing organisation, should be created for the government of the Institute. This body should be thoroughly representative of the great commercial and industrial interests of the Empire. The Colonies and India should have a fair share in the government of the Institute, and each colony should have special charge of its own particular department, subject, of course, to the general management of the entire institution.

The method of carrying this out would be prescribed by the Charter after full consideration by Her Majesty in Council.

D.—Site.

The Committee being fully conscious of the advantage of a central position for the Institute, have considered the various possible sites, and have, as far as has been within their power, obtained estimates of their cost.

To carry out the several objects which the Committee have indicated, a large space is necessary. The Committee have been unable to find any such suitable site in the central parts of London, except at a cost which, looking at the probable amount of subscriptions, would, after the purchase of the ground, leave a sum wholly inadequate for the erection and maintenance of the buildings, and for carrying out tbe objects of the Institute.

The site of about five acres recently secured for the New Admiralty and War Offices is valued at £820,000, or rather over £160,000 per acre; that now vacant in Charles-street, opposite the India office, is less than an acre, and would cost, at least, £125,000; probably another acre might be secured by private contract, so that the value of a limited site in this position would not be less than £250,000. It has been suggested that a single acre not far from Charing-cross might be obtained for £224,000. Two and a half acres on the Thames Embankment have been offered for £400,000; and it is stated that six acres might be procured from Christ's Hospital at £600,000. Another good central position has been suggested, consisting of two and a half acres, which has been valued at £668,000.

It is, of course, probable that these sites might be obtained at somewhat less than the prices asked, but allowing for this, it is obvious that the purchase of any adequate area would involve the expenditure of a quarter to half a million.

The Committee have therefore been forced to abandon the hope of obtaining a central site within the limits allowed by any probable subscription.

The attention of the Committee was then drawn to the property at South Kensington belonging to the Commissioners for the Exhibition of 1851. This property was bought out of the profits of that Exhibition, with the express object of offering sites for any large public buildings which might be required for the promotion of Science and Art.

Under these circumstances, the Committee submit to your Royal Highness that the Imperial Institute may well establish a claim for the grant of a site of sufficient magnitude on property bought and reserved for public institutions of this character.

Though sensible of the objections that may be urged against the situation at South Kensington, the Committee think that the advantage must be obvious of obtaining a sufficient site virtually free of cost, so that the whole of the subscriptions may be devoted to providing a building for and establishing and maintaining the Institute.

The Committee, whilst guided in the recommendation of a site by the considerations they have indicated, think it right to add that there are some incidental advantages connected with that at South Kensington.

In that locality are combined the City and Guilds Technical College, the Royal College of Music, and the Government Museums and Schools of Science and Art, which ought to be in immediate proximity to an Imperial Institute of the character which we have described.

The technical character of the collections and exhibitions of the Imperial Institute has a natural connection with the collections of Science and Art in the Government Museums.

E.—General Observations.

An Imperial Institute for the United Kingdom, the Colonies, and India, would fail in its chief object if it did not constantly keep in view that it ought to be a centre for diffusing and extending knowledge in relation to the industrial resources and commerce of the Empire.

The necessity for technical education is now fully appreciated, because the competition of industry has become, in a great measure, a

competition of trained intelligence. The Committee, however, do not recommend that the Imperial Institute should aspire to be a College for Technical Education. Many of the large towns in Great Britain have recently established Colleges or Schools of Science and Art. The Imperial Institute might serve to promote technical education in these, and to unite them with colleges of larger resources which have been founded or formed branches for the purpose in the metropolis. It is too much to hope that an active co-operation of this character between the provincial centres and London could be at once undertaken by the Imperial Institute. But the Committee bear in mind that, in their last Report, the Commissioners of 1851 have indicated an intention to assist in carrying out such a scheme. If the Commissioners would contribute three or four thousand pounds annually, it would be possible to establish scholarships which might enable promising candidates of the working classes to attend local Institutions, and even, when it was desired, to complete their technical education in colleges of the metropolis. In addition to this aid, the Imperial Institute might be able, in other ways, to promote the foundation of scholarships both in connection with the Colonies and provincial centres, in the hope of still further extending these benefits to the working classes.

In conclusion, the Committee submit that an Imperial Institute, such as they have sketched in broad outline, would form a fitting memorial of the coming year, when Her Majesty the Sovereign of this Empire will celebrate the Jubilee of her happy reign. It would be an emblem of the Unity of the Empire, embracing as it does all parts of the Queen's dominions, and tending to promote that closer union between them which has become more and more desired. It would exhibit the vast area, the varied resources, and the marvellous growth, during Her Majesty's reign, of the British Empire. It would unite in a single representative act the whole of her people; and, since both the purpose and the effect of the Institute will be to advance the industrial and commercial resources of every part of the Empire, the Committee entertain a confident hope that Her Majesty's subjects, without distinction of class or race, will rejoice to take part in offering this tribute of love and loyalty.

HERSCHELL, *Chairman*.
CARNARVON.
REVELSTOKE.
ROTHSCHILD.
G. J. GOSCHEN.
LYON PLAYFAIR.
HENRY JAMES.
HENRY T. HOLLAND.
H. H. FOWLER.
C. T. RITCHIE.
FRED. LEIGHTON, *President of the Royal Academy*.
ASHLEY EDEN.
OWEN T. BURNE.
REGINALD HANSON, *Lord Mayor*.
J. PATTISON CURRIE, *Governor of the Bank of England*.
JOHN STAPLES.
FREDERICK ABEL, *Vice-President of the Society of Arts*.
J. H. TRITTON, *Chairman of the London Chamber of Commerce*.
NEVILE LUBBOCK.
HENRY BROADHURST.

NOTICES.

JUVENILE LECTURES.

All the tickets for these lectures having now been disposed of, the issue is stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

CANTOR LECTURES.

The fourth and last lecture of the course on the "Principles and Practice of Ornamental Design," was delivered on Monday evening, 30th inst., by Mr. LEWIS FOREMAN DAY, who dealt with natural form and ornamental treatment.

A cordial vote of thanks to the lecturer was passed, on the motion of the CHAIRMAN.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Two Gold Medals and Four Silver Medals for prime movers suitable for electric-light installations.

The medals will be awarded on the results of practical tests.

The motors will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class.

(A.) Motors in which the Working Agent is also Produced.

Steam.—Ordinary portable or semi-portable non-condensing engines.

Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer.

Petroleum vapour.

Liquid petroleum.

(B.) Motors to which the working agent must be supplied.

Steam.—Detached engines, non-condensing, without boilers.

Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas.

Hydraulic.—Water motors.

Each class will be subdivided into two groups—those declared to develop not more than 10 h p., and those which will develop more than 10 h.p. and less than 20 h.p.

The entrance fee will be £2 10s. per h.p., to be paid on entry.

All engines and boilers must be fitted up in accordance with the Regulations of the Royal Agricultural Society.

The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

The Council will publish the awards in the *Journal* of the Society of Arts. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

[The full text of the conditions under which the medals are offered is given in the last number of the *Journal.*]

Proceedings of the Society.

CANTOR LECTURES.

PRINCIPLES AND PRACTICE OF ORNAMENTAL DESIGN.

By Lewis Foreman Day.

Lecture I.—Delivered November 29th, 1886.

When this series of Cantor lectures was first suggested, I was told that I must not take for granted any special knowledge of the subject on the part of my audience. If, therefore, what I have to say should appear to any of you rather too elementary, I must claim your indulgence. What I have taken for granted is, that you want to know. My idea is to tell you what I know on the subject of ornament—and to be as little tedious as I can in the telling.

One more word of preface—as to the illustrations on the walls. They are chosen more with a view to illustrate what I have to say than for any intrinsic interest in them. They are all numbered, and they are arranged (I hope) consecutively; so that, if you will keep an eye on them as I proceed, it will help you to follow me—and even to anticipate my meaning, perhaps.

The Anatomy of Pattern Design.

Pattern comes of repetition. Many a pattern bears on the very face of it the evidence that it grew directly out of the necessity of repetition. You see this very plainly in the chequer, which is the product of plaiting; in the lozenge or diamond pattern, which is anticipated in the meshes of the simplest form of netting; in the herring-bone, or zigzag, which is derived from basket-work. Even the elaborate interlacing ornament of Arab art is based upon an arrangement of cross lines, very much as you may see them in the common cane-bottomed chair.

It is more than probable that some mechanical necessity gave rise to *all* geometric pattern: certainly it is impossible to plait, net, knit, weave, or otherwise mechanically make, without producing pattern. It may be so small (as it often is in weaving) that the warp and weft are invisible to the naked eye; but it is there, and all that remains for us to do is to efface it all we can, or to make the best of it. Out of the determination to make the best of it has

grown much of the most beautiful pattern-work. To neglect this source of inspiration, therefore, to say nothing of the attempt to suppress it, would seem to be wasteful of opportunity to the last degree.

The very repetition of parts, then, produces pattern, so much so, that one may say that, wherever there is ordered repetition there is pattern. Take any form you please, and repeat it at regular intervals, and you have, whether you want it or no, a pattern, as surely as the recurrence of sounds will produce rhythm or cadence.

The distribution of the parts need not even be regular. The wave marks on the sand, the veins of marble, the grain of wood, the crystalisation of the breath upon the window-panes, the curl of the hair, the very features of the human face—resolve themselves into pattern. So distinctly is this last the case, that the ornamentist finds himself continually devising, *malgré lui*, patterns that remind one of faces. There is room for speculation whether it may not have been with a view of escaping this danger, or anticipating it rather, that the designer first took to the deliberate use of those masks and grotesque heads which form so prominent a feature in ornamental design.

The popular idea of the process of ornamental design is that the artist has only to sit down before a piece of paper, and, spider-like, spin out the fancies that may crowd his fertile imagination. Indeed, there is scope in design for all his fancy; but he is no Zeus, that ornament should spring, Pallas - like, full-grown from his brain.

Ornament is constructed patiently (I will not say laboriously, for the artist loves the labour), patiently built up on lines inevitable to its consistency—lines so simple that to the expert it is not difficult to lay bare its very skeleton ; and just as the physiologist divides the animal world, according to anatomy, into families and groups, so the ornamentist is able to classify all pattern-work according to its structure. Like the scientist, he is able even to show the affinity between groups to all appearance dissimilar ; and, indeed, to point out how few are the varieties of skeleton upon which all this variety of effect is framed.

Before enumerating these varieties, let us suppose for a moment a man to imagine (and this is by no means an imaginary case) that he will make to himself a repeating pattern without regard to its logical construction—as though in his domain there should be no skeletons. That would be, from my point of view, a profoundly foolish thing to do ; but, more than that, it is impossible. He may design a unit in which there is no repetition, and no formality, but the moment he repeats that unit, the very order of its repetition proves to be, if I may call it so, the cupboard in which the skeleton will be found.

It might be imagined that by designing in some such haphazard fashion as I have just supposed, the artist would secure to his design a freedom of line, an absence of formality, not readily to be obtained by adopting the more systematic method. But this is not by any means so. If, indeed, the design be of that absolute uniformity all over that there is no one feature in it more pronounced than another, it may pass muster notwithstanding the want of backbone. But that is not to claim much for it as a design. And it was scarcely worth the pains to take exceptional measures merely to this insignificant end.

If, on the other hand, a design be above the level of insignificance, there must be in it some dominant feature or features which, when many times repeated, will appear more prominent than ever. It is to these features that the eye will irresistibly be drawn ; and it is the lines they take in relation one to another which will assert themselves. It is hardly to be expected that if these lines have never been taken into consideration they should come out very satisfactorily—and, as a matter of experience, they always come out awry. You must all have suffered more or less from wall-paper and other patterns, in which certain ill-defined but awkward stripes impressed themselves upon you ; and you may have imagined possibly, if you thought about it, that this effect of stripes came of working upon vertical, horizontal, or diagonal lines. It was much more likely the result of not working upon definite lines at all. A designer who knew the A B C of his business would make sure of lines not in themselves offensive ; he would counteract a tendency to stripes in one direction by features directing the attention otherwards ; and he would so clothe any doubtful line that there would be no fear of its asserting itself, as in its nakedness it might. He foresees the danger (and it is a danger even to the most experienced of us) and he is fore-armed against it. The mighty man of valour who disdains to be trammelled by any such encumbrance, is without defence against contingencies practically certain to arrive. It is only by a miracle, or a fluke, that he can

escape failure. The overwhelming odds are, that the petty considerations he has despised will be quite enough to wreck any venture he has dared in defiance of them.

Since, then, it is practically inevitable that there shall be definite lines in ornamental design—seeing that if you don't arrange for them they arrange themselves—it is the merest common-sense to lay down those lines to begin with, and, in fact, to make them the skeleton or frame-work upon which you build up your pattern.

Let me now lay bare these skeletons for you. You will see that they are, after all, very few.

First in order of obviousness comes the *stripe*—and very early also in order of invention: for the loom must from the beginning have suggested the stripe-pattern. It grows out of it. But the stripe carries us only a very short distance in the direction of design. For immediately you make any break in the repeated line, the recurrence of that break gives other lines in the cross direction. Take a series of horizontal bands broken by rosettes at equal intervals. If the rosettes fall one under the other they give upright lines; if they are shifted you get diagonal cross lines. Or, if the line itself is broken, as in the case of a series of waved lines, or, still more plainly, in a series of vandykes, the turn of the waves, or the point of the zigzag, when repeated, it gives the cross line just the same.

And so we come at once to the vast order of patterns constructed upon cross lines—probably quite the first in point of time, arising, as it inevitably does, out of the very primitive art of plaiting.

By the simple interweaving of strips of two different colours we get at once the *check* or chess-board pattern. If the strips are all of one tone, then the lines of intersection make a lattice or basket-work pattern.

The simplest form of check or lattice is when the crossing is at equal intervals and at right angles. Vary the interval, and you have all manner of plaids and tartans. Alter your front of view (or turn the design 45 degrees round) and you get *the diamond*. The difference in point of view makes no real difference in plan—a stripe may take any direction, but it is always a stripe. But if we alter the angle at which the lines cross, we get not only a fresh variety of shapes, but we get also a diamond shape which, for the sake of clearness, I will call *the* diamond, which plays a very important part in the next order of patterns, at which, however, we have not yet arrived.

Returning to our network of cross lines, there is no particular reason why they should always be filled in alternately, *à la* chess-board. They may just as well be grouped in twos, threes, fives, and so on—resolving themselves into patterns of great variety and even of intricacy, as in the case of the fret, and thus an ever increasing range of pattern-work discloses itself, all built upon one and the same constructional scaffolding.

This theory, however, must not be pressed too hard, or you may squeeze something very like a false idea out of it. It might be contended that all patterns are formed on the square, or all patterns, at least, that can be woven, the threads forming the squares on which the design is laid. This is obviously absurd. The only patterns built on the square are those in which the artist (consciously or not) worked upon those lines. The actual squares of a coarsely-woven scroll, or of a pattern in Berlin wool, belong, not to the pattern, but to its translation into a textile fabric.

If instead of the chess-board we take the lines of the lattice and work upon them, we get, without departing from those lines (only intermitting them) a wonderful range of interlacements and the like. From the intermission of the lines results a kind of spot pattern, more or less free, which might be mistaken for a distinct order of design. But it is only a variety. It really matters little whether a design is constructed on geometric lines, or only arranged so that it falls within them. The skeleton, when you come to dissect the two, is the same in either case; and I would ask you to bear in mind that what I have said, and am saying, applies quite as much to sprigs, spots, and all so-called free patterns, as to those in which the constructional lines actually occur as lines. You have not done away with construction when you have succeeded in keeping the scaffolding out of sight. Again, the use of the broken line, instead of the straight, makes no difference except in effect. The skeleton is the same, though you use a sort of conventional flash of lightning instead of a straight line.

So far we have had to do only with the simplest of all possible schemes, in which at most two series of lines intersect one another. The introduction of a third series of cross lines constitutes a new departure, and a most important one. Cross the chess-board by a series

of lines bisecting the right angles (cutting the squares in half, that is to say), and you have a new form to work upon—*the triangle*.

But it is the equilateral triangle which is the most useful factor in design. This is obtained by crossing an elongated diamond pattern by a series of lines bisecting its obtuse angle; and once you have the equilateral triangle, you have only to group the units to get the hexagon (a group of six triangles), the star (a group of twelve), and other shapes, such as that formed by a group of eighteen triangles, or of three hexagons.

Our scope is now immensely widened. We have the basis of an infinity of geometric patterns, such as we find in Byzantine mosaic work, and in its Moresque derivatives.

By the use of a fourth series of cross lines at right angles to the last, again a new shape is evolved. If, that is to say, you cross the square lattice diagonally both ways (cross it by itself, that is), cutting up each square into four, you get out of these lines the *octagon*, but not an equal-sided one; that is built on a different lattice.

The octagon, however, is not a unit which will of itself form a diaper, as the hexagon will. It is only in connection with the square, diamond, or other four-sided figure that it will repeat. Nevertheless, this new series of lines gives us new varieties of radiated patterns. Witness, again, the elaborate interlacings of the Arabs, all of which, even the most magnificent, are closely related to the seat of a common cane-bottomed chair.

It is possible to carry the principle of *radiation* further still. You may, for example, cross this more elaborate lattice by a lattice like itself—but you get by that means rather intricacy than variety. In certain Arab patterns, where this ultra-elaboration of lines is employed, it appears almost as if a new principle had been introduced, but upon an analysis the designs resolve themselves into the elements with which we have already had to deal. Here, then, we have come to the end of the straight-lined family.

Why, it may be asked, can you not make a diaper on other lines, on the lines of the pentagon for example? Well, you may put together so many pentagons—and a very respectable diaper they form—especially if you further enrich the pentagons with five pointed stars. I came upon just such a diaper a little while ago, which, for the moment, promised to upset all my neatly arranged theories on the subject of pattern anatomy. I had only to dissect it to discover that it was our old friend the diamond in disguise; but so artfully made up as at first sight to deceive. There it is. It consists of pentagons put side by side, the interstices between them ingeniously filled with stars and triangles, much as the pentagons themselves are filled—so that one does not readily distinguish between the parts. You want no telling that shapes of any kind may be put together to form a pattern; but that does not alter the fact that the lines on which they are arranged, or into which they fall, must be those I have already laid down, which are indeed the base of all possible pattern.

For further variety in design, we must resort to the use of the *circle*. The circle itself must, indeed, be arranged on one or other of the foregoing plans. It must be struck, that is to say, from centres corresponding to the points of intersection of lines such as have already been described. In so far, it is only one of the innumerable arbitrary shapes that may be so arranged, But the circle is so important a feature in itself, it so entirely alters the scope of geometric pattern, that it deserves to be considered apart. One cannot simply ignore the element of curvilinear design in ornament.

Whether the idea of flowing forms first grew out of the circle is of no great consequence. It is more than probable that instinct preceded geometric principles. Many of the common flowing patterns may be deduced directly from *angular* motives. The wave, for example, is a zigzag, just blunted at the points. Soften the lines of the hexagon, and you have the ogee. Interlace straight rods, and you get waved lines, as in the common hurdle. Round the corners of the hexagon or octagon, and you arrive at a rude circle. The relation of the hexagon or octagon diaper to the diaper of circles is obvious. I take it that the bee merely works in a circle, and that the hexagonal form of the cells of the honeycomb is the result of gravitation, just as you find that cylinders crowded all become hexagonal prisms.

However, the circle itself is familiar to man from the moment he first sees the sun or moon as a disc in the sky, just as the principle of radiation is plainly perceived in the stars. For all we know, the very first pattern ever traced by man's hand may have consisted of circles. The primeval artist had only to break off a dry twig and indent the damp earth with the end of it, to get a series of round impressions which would pass for a very respectable diaper. I don't say that was so. I only mean to in-

sist upon it that the lines on which patterns are formed can be reduced to the simplest, and that they, so to speak, force themselves upon the workman—making him, as it were, an artist in spite of himself.

The circle, with its segment, the curve, and its compound, the spiral, assumes extreme importance when we come to the consideration of the scroll (with which just now we are not concerned), but it will be seen that, even in mere diapers, it leads to an apparently new order of things.

The simplest form of circle diaper is when the circles are arranged on the square or the diamond plan, and so as to touch at the edges. By the intersection of the circles one by another an effect of much greater elaboration is at once obtained, and it makes all the difference whether you determine the proportions of the circles according to the lines on which they are struck or not. Out of the circle or its segments we get also the trefoil, the quatrefoil, and all manner of cusped shapes, which also must needs be put together on one or other of the plans already propounded.

Further, out of the segments of the circle you can construct the scale pattern (which might equally have been derived from the scales of a fish or the plumage of a bird's neck). The scale may also be considered as a translation of the diamond into curved lines. Re-arrange the scales and you have a more graceful as well as a more complicated diaper —in which appears the ogee shape—once before referred to as being a curvilinear modification of the hexagon. The hexagon itself may be deduced from it. Suppose a network of interlacing wave lines or ogee shapes—it amounts to the same thing—and the result is a series of six-sided figures, very nearly approaching the straight-lined hexagon. In this way the straight-lined series might be derived from the curved; and so once more, by a very different road, we reach always in this maze of pattern work the same point, which is the limited variety of the skeleton on which pattern is built.

From the combination of straight lines with curved result new diaper forms, which, however, present nothing very new in the way of skeleton. You might start a scroll pattern, such as was common in the 16th or 17th centuries, on the lines either of the hexagon or the ogee, or a mixture of curved and straight lines, which I may call the broken ogee; and in the end it would not be very clear which of them you had taken for a ground work—or even whether you had not founded your design upon the diamond—such close kindred do those various skeleton lines betray.

I have dwelt at some length upon rudimentary diaper forms, for reasons quite apart from anything intrinsically interesting or beautiful in them, although they may be both one and the other. More especially is this likely if tender colours be employed to soften the forms, or if the colour variations do not quite follow the pattern, as in the case of marble inlay, where the accidental colour of the marble itself is a relief to the geometric monotony of the shapes. The Japanese sometimes go so far as to interrupt the pattern, wiping out a bit of it here and there, anticipating, indeed, the softening effect that age might impart to it.

But it is more as a *basis of design* that we have at present to consider geometric forms. The basis of all repeated patterns is, as I said, geometric—and, this being so, it is as essential that the designer should be acquainted with simple geometric principles as it is that a figure draughtsman should have some knowledge of superficial anatomy.

For all the simplicity of the skeleton lines he has to deal with, the pattern designer's art is not such a simple thing as you might suppose. He has not merely to invent pretty patterns, but patterns that can be conveniently worked—and the lines mapped out for him by the conditions of his work, are, in most instances, not just those which beauty would have decreed.

They prove, however, to be identical with the lines already shown to be the basis of all recurring pattern-work—and so we begin to see that, had there been no such thing as pattern design before, and no traditional forms of design for us to follow, those very forms must have been evolved as certainly out of the more complex conditions of modern manufacture as they were out of the simple contrivances of primitive handicraft. That is to say, that the lines first given to us by the primary processes of netting, plaiting, and so on, would equally have been prescribed by the printing roller or the power loom.

It is one of the most interesting points in the analysis of pattern design to see how regularly we work round, again and again, to identically the same shapes. You cannot safely dogmatise as to the origin of this or that pattern, there are always so many ways in which it might have been suggested. Put side by side a series of waved lines so that their curves are opposed, and the effect is

exactly the same as though you had opened out an ogee diaper; you can deduce either pattern from the other. Or again, if the ogees interlace, it is impossible to say whether this was the outcome of the ogee, or of waved lines, or simply of the process of netting. To take another instance of a very different kind, you know how common it is to see a waved line with leaves alternating on each side of it. It appears, on the face of it, a quite mechanical and arbitrary arrangement; but you have only to note, in nature, how the alternate leaves on a slender stem pull it out of the straight to see the natural and inevitable origin of the idea. By merely exaggerating the slight wave of the natural stem, you get one of the most conventional of ornamental borders.

So it would seem that, whether you begin with mechanical construction or with nature, it works round, in the hands of an ornamentist, to the same thing in the end—only in the hands of an ornamentist.

But this is something of a digression. I will just show you how in block printing, for example, which strikes me as presenting comparatively few limitations, the lines of all, or nearly all, possible design are laid down for us, and indeed might be deduced from the conditions of printing.

In the first place, it is of the utmost convenience, if not of absolute necessity, that the printer's block should be rectangular. We have thus, for the base of our operations, a parallelogram of more or less arbitrary proportions. For instance, English paper-hangings are invariably twenty-one inches wide, and, as a block of greater length than that would be unwieldy, we are restricted to a square of 21 inches by 21 inches.

The block might represent a fraction only of the design, which may theoretically be made up of as many blocks as you please. But in practice the expense of such a proceeding would make the paper-hangings cost more than paper-hangings are ordinarily worth; and apart from the commercial considerations, which would be enough to prevent that kind of extravagance, it is contrary to craftsmanship so to misapply labour. The most capable artist is he who can apply his art to most purpose, and get full value out of his materials.

As a matter of fact, the wall-paper designer has to content himself, then, except in very few instances, with a repeat of at most 21 inches square. Within those limits he is comparatively free; but, as I have already shown, do what he will, his repeated pattern *will* fall into geometric lines, if only those of the parallelogram on which it is built. It is just so with designers for other manufactures. The cretonne printer allows you a smaller square, and the carpet-weaver a larger one—that is all. The possible lines of pattern construction are, therefore, not always and in every case possible.

In fact, we have ordinarily to consider those lines in relation to the rectangular figure which is the repeat determined for us by the conditions of nearly all manufacture. The Oriental mind, delighting in geometric intricacy, has availed itself largely of the triangular unit, and has built up with it all manner of delightfully elaborate patterns. The modern European finds it more convenient to him to adopt the simpler parallelogram. He may now and then use hexagonal or other many-sided tiles, but he prefers the square. So also the weaver's cards are inevitably in the shape of parallelograms, and the printer's blocks; and though the printer makes use of the roller instead of the block, the conditions of design remain unaltered; for the roller is, for all practical purposes of design, only a block bent round in the shape of a cylinder.

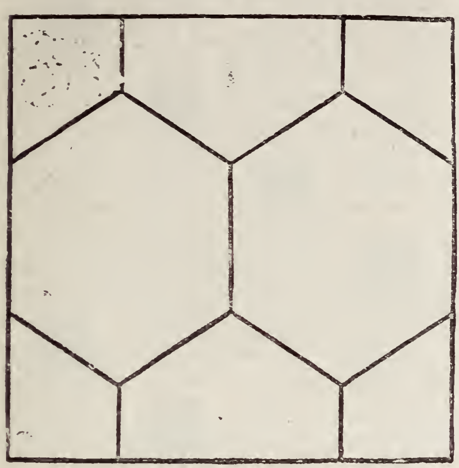
Another consideration of practical design is that, for reasons both of manufacture and commerce, it is found convenient to adopt certain fixed dimensions for the tile, block, roller, or whatever it may be—and we are thus constrained to design tiles (if they are to be of any use) on the accepted three, six, or eight-inch scale; textiles to a width fixed by the loom, and a length controlled by the consideration of economy; block-printed fabrics under very similar conditions; and roller-printed to a length as well as a width prescribed.

It would be out of place to go more fully into the various technical reasons for these limitations in design. The practical convenience of them, however, is patent. It is as desirable that the architect, for example, should know what sized tiles may be available, as that he should be able to reckon upon the "bond" of his brickwork; and it is equally clear that without some uniformity in the width of materials (such as silks, velvets, carpets, chintzes, and so on), it would be difficult to estimate off-hand the relative cost of each. As it is, the public is sometimes misled in that way. The difference between eighteen and twenty-one inches in width is not so apparent to the eye that the purchaser of a French wall-paper need realise, when he selects it, that

it is actually nearly seventeen per cent. dearer than an English paper nominally at the same price!

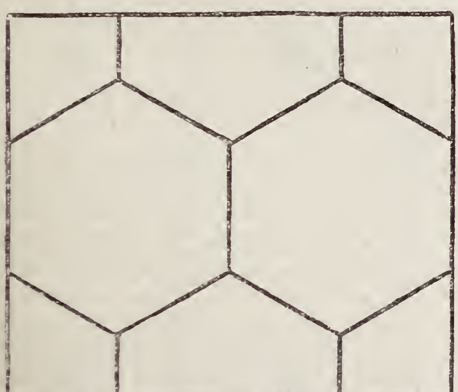
To return to the subject. The upshot of it is, that the designer has habitually to shape his design according to a rectangular plan, and that of limited, if not fixed, dimensions.

FIG. 1.



It becomes, then, a very serious question with him how far he can avail himself of any other basis. And it would be interesting to tabulate the possibilities in the way of adapting the various units of repeat to repetition within the square. It would then be seen that, though

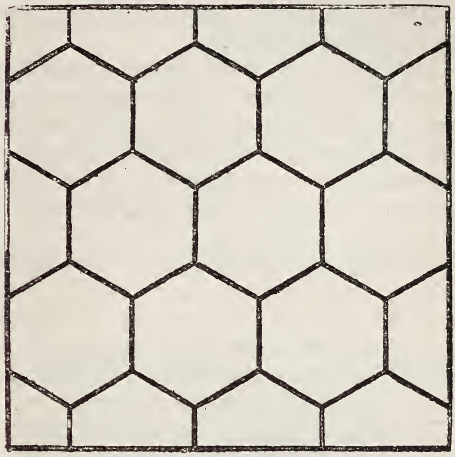
FIG. 2



all things are possible, there are many plans the artist would like to adopt, which, in order to be brought into the repeat permitted, would need to be reduced to so small a scale as to be too insignificant for any useful purpose.

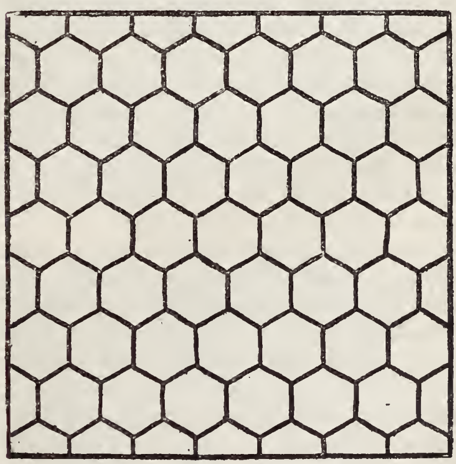
One instance I may give. Suppose a square block of 21 inches, and you wish to adapt an hexagonal design to it. Have you any notion how small the hexagons would come? If you made your hexagons $10\frac{1}{2}$ inches wide, so as to get two in the width, they would not come true in the length; they would be too long (Fig. 1). If you made them true, they would not fill the square, but only a space about 21 inches by 18 (Fig. 2).

FIG. 3.



Three-and-a-half hexagons in the width would work, but only as a "drop" pattern; that would give hexagons of six inches across (Fig. 3). In order to occupy the square with true

FIG. 4.



hexagons repeating without a "drop," they would need to be reduced to half that size; that is to say, there would have to be seven hexagons to the width, measuring each only three inches across (Fig. 4).

I have worked this out in diagram form, in

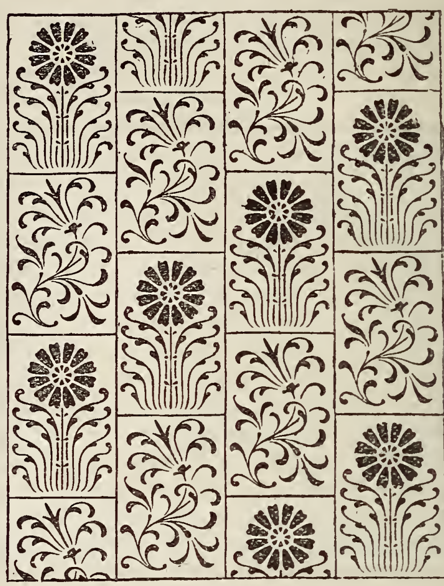
order that you may more distinctly realise how strictly the artist is bound by considerations which scarcely occur to the uninitiated, considerations which have always had a great deal to do with the design of pattern-work. Fashion has had her say in the matter, no doubt—it is a wicked way she has; but though certain lines have been generally adopted at certain periods and in certain countries, I think it will invariably be found that there was some technical practical reason for their adoption in the first instance.

Out of the conditions of weaving came, for example, the adoption of upright patterns and cross colouring (as on the silks of Byzantine, Sicilian, and early Italian design), as well as the turning over of the design on the two sides of an upright stem, or purely imaginary central line.

All things considered, the most useful skeleton to work upon is the diamond. It is on the basis of the diamond that "drop" patterns are most readily designed. The "drop" is a device by means of which the designer is enabled, without reducing the scale of his work, to minimise the danger of unforeseen horizontal stripes in his design, a danger which is imminent when the repeats occur always side by side on the same level. The printer's block, we will say, is a square; or the roller is its equivalent; or the cards take that form. In the printed or woven strip, whether paper, cretonne, silk, or what not, the end of one repeat must tally with the beginning of the next, in order that the pattern may be continuous throughout the piece. Equally of course the design must be so schemed that the right side of one piece of the stuff will fit on to the left of another, and so on. But it is clear that the design may be so contrived that each succeeding breadth has to be dropped in the hanging.

If this drop is only very slight—say three inches—it would take seven breadths in a pattern of twenty one inches deep before a given feature in the design occurred again exactly on the same level. There would be no danger then of any horizontal tendency in the lines, but, on the other hand, great likelihood of a diagonal line developing itself with even more unfortunate effect. The design steps downwards, and the shorter the steps, the more noticeable is the line they take. You may see something of the sort in Fig. 5. This difficulty is avoided if you make the "drop" just one-half the depth of the pattern, so that every alternate strip is hung on the same level. Then the diagonal lines correct one another. If any line at all asserts itself, it is a zigzag (instead of a step), which, in

Fig. 5.



connection with corresponding zigzags above and below, may very possibly form a trellis of diamonds.

Fig. 6.

You see the zigzag resulting from a "drop" in Fig. 6.

So, you will see, I had good reason for

saying the diamond was a useful plan to work on, for upon it is formed the safest form of drop pattern—that, namely, which drops one-half its depth.

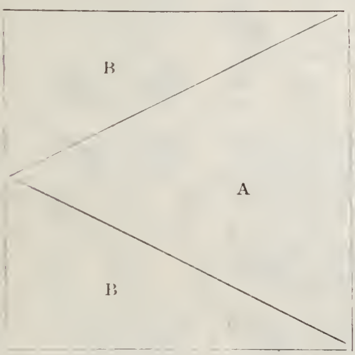
The designer finds it more convenient to design at once upon the diamond lines, because their simplicity enables him better to keep in view the effect of his pattern in its repeated form than any other lines (there are others) on which the drop can be worked.

I have often heard persons, more familiar with the forms of ornament than expert in practical design, complain of the difficulty they experience in scheming a "drop." If they would only think of the problem as the filling of a diamond shape, it would come very easily to them.

When the pattern within the diamond is symmetrically disposed on the two sides of a central upright line, the artist has the opportunity of working out a design which is apparently twice the width at his disposal.

If you divide your block of 21 inches thus,

FIG. 7.



so that B B together equal A reversed, it amounts to the same thing as though you designed upon the basis of a squat diamond 21 inches high by 42 wide—so long, that is, as one side of the pattern is an exact reverse of the other: otherwise it would not hang. The advantage is, of course, only apparent—what is put into one strip is taken out of the other—but in the case of a pattern, appearance goes a long way. Indeed, it is difficult to over-estimate the value of this expedient in design—the common property of designers for all manner of fabrics—but undreamt-of in the philosophy of the ordinary amateur.

Theoretically, it is all the same whether you design a drop on the lines of the square, on the slant, or on the diamond, you may arrive

FIG. 8.

in either case at identically the same result. You might snip pieces from the four corners of the square, and make with them the diamond; or if you dispose them differently, you produce the oblique shape. This amounts to the same thing as though you had cut off only two corners and transposed them; but, practically, it makes all the difference in the world which plan you adopt. Your design must be influenced to a very considerable degree by the shape you set yourself to fill. It would never occur to you, for instance, to stretch a festoon or wreath across a width of space you did not see before you; so that it may be fairly said, that such extension of the design beyond the width of the material, is the direct result of working on the lines of the diamond: whilst you are designing within the lines of the square, you have naturally no impulse to go beyond its limits.

Even though you have no wish to avail yourself of the full width of a block, you may still find it convenient to design within the diamond, if only in order to economise design: and, mind you, economy is an absolute necessity of the case. But for economic reasons there would be no weaving, printing, stamping, and so on; we should confine ourselves to embroidery, tapestry, painting, and other work of our own hands.

The designer, then, often begins by dividing the width of his block into halves, and so on; and, by forming his diamonds on the lines thus given, obtains variety of scale.

But although, however you start, you come back always to the same few schemes; and although in any case your pattern might equally have been designed upon other lines, working on those lines it never would have occurred to you.

This pomegranate pattern (Fig. 9), for example, though it *might* have been planned on the lines of the diamond, would much more likely occur to one working on the lines of the parallelogram schemed to drop.

There is this excuse, and only this excuse, for puzzling over all these varieties of skeleton.

I have shown how a pattern designed on one plan might have been (though it would not have been) designed on another plan. It is a good test of your design, if you have roughed it out on one plan, to make the finished drawing on another. By that means you see it, as it were, from two points of view—you see how it repeats without drawing much of the repeat.

Whatever the lines of the skeleton, in any important work they are usually disguised. Sometimes they are so crossed and interlaced that it is difficult to follow their intricacy. Or they may be interrupted so that you lose the thread of the design. Or, again, two or more schemes of ornament may be, so to speak, interwoven, the one asserting itself here, the other there; so that the bone-seeker is, as it were, put off the scent. Further, features may be introduced of such importance in the design that the eye is drawn to them, and fails to perceive the geometric connection between them.

Fig. 9.

Obviously, however, the most effective way of disguising the skeleton is to clothe it, as nature does, and the most natural way of doing this is with something in the nature of foliation, beneath which the bare constructional lines are as little noticeable as the stiff branches under their burden of leaf and blossom. By this means, you get at once life, interest, and variety so great, that I doubt whether, even after this lengthy explanation on my part, you will all of you quite believe in the absolute simplicity of the skeleton forms underlying all pattern.

The foliated scroll (as you see it, for

example, in Roman or Renaissance Arabesque) looks almost as though it were impossible of geometric construction—and, of course, it is never mathematically built up. But, for all that, it falls into the familiar lines. The spiral itself is only a series of segments of circles; and if you dissect any repeated scroll-pattern, you will find most likely that its back-bone is a wave line or spiral—certainly you will find it *has* a back-bone—pattern is a vertebrate thing, and in a scroll the spinal cord is very decidedly pronounced. You can easily see when a scroll is broken-backed. It is only by experience that a designer learns to know what may, and what may not, be done within given lines. Many a notion which one had a thought of adopting, turns out to be practically quite unamenable to the conditions.

You cannot draw a bold, flowing scroll without considerable allowance in the way of length in the blocks, cards, or whatever it may be; nor can you well avoid a certain upright tendency in patterns where the width is very much restricted. The fact of the matter is, the characteristic lines of time-honoured patterns are mainly the direct result of the conditions under which the craftsman was working.

It was in some degree owing to the facility with which triangular cubes of tile could be manipulated, that the peculiarly Eastern form of geometric ornament arose. So also with us, the proportions of the square tile have resulted in a distinctly characteristic form of ornament.

I do not pretend to say whether the turning over of the design which prevails in early silks, was suggested by the fact that the turning over could be so readily done in weaving; but it looks, at all events, as though the Sicilians adopted that plan of design because by means of it they could at once double the scale of their pattern. The weaver of our own day adopts it on the simple economic grounds that one set of cards does thus for the two sides of the design. It has been said that the idea of reversing a pattern owes its origin to the circumstance that you may double a sheet of paper, and so, with one action, cut out the two sides of it. If that is not so, it well might be—except that probably reversed patterns were common long before paper was. What can be done with folded paper can be done, however, with two or more *planks*, which can thus be fretted by one action of the saw—a practice out of which a distinctly characteristic form of Swiss timber ornamentation arose. Bands or stripes of different colours are so common in Eastern curtains, blankets, &c., because they can be so easily woven. Even in more elaborate silk and other designs, certain of the colours are very often distributed band-wise. The variety of colour so obtained is obviously due to the ease with which the weaver can change his shuttle.

In Sicilian and early Italian silk fabrics (it is from Sicily that the art of silk-weaving was introcuced into Italy), both the turning over of the pattern and the banded arrangement of the colour are very frequent, indeed, so much so as to form quite marked features in the design of the 11th and following centuries. Designers would be the more ready to adopt such a plan, in that the horizontal line due to it was not anyways injurious to the effect of a fabric meant to fall in folds. The dim vertical line, which was also likely to occur, was calculated to lose itself in the more strongly marked verticality of the folds; and the horizontal band had an absolute value in marking the fulness of the hangings.

In flat decoration the horizontal band is less unobjectionable, and it is for that reason that so many of the wall-paper patterns, borrowed or stolen from good old stuffs—by their stripes you shall know them—are altogether unsatisfactory on the wall. To me horizontal stripes always suggest the ample hanging, and seem to want the folds.

In adapting a design, then, from one material to use in another, it is not enough to copy it; it needs to be translated, which translation is not so easy but that an artist gifted with any invention of his own will find it, on the whole, better worth while to say what it is in him to say for himself, and not go on harping on the old, old tunes, melodious though they be.

Anyway, it is puzzling enough for us all to have to design to-day under these conditions and to-morrow under those. Yet there is relief in the very variety of the efforts expected of us; and in the presence of difficulties, our ingenuity, if we have any, is excited. The more difficult the conditions, the more they provoke solution. A designer must have in him something of pugnacity; he must enjoy attacking a tough problem. A man proves himself a designer, not because he has somehow arrived at a design, but inasmuch as out of unpromising material and untoward circumstances he can shape a thing of beauty.

Miscellaneous.

MANUFACTURE OF TOFU IN JAPAN.

The United States Minister at Tokio says that considerable attention is paid in Japan to the manufacture of *töfu*, or bean curd, which approaches more nearly in its chemical composition to animal food than any other vegetable known. It contains about one-fifth of its weight of fat, and nearly two-fifths of nitrogenous matter; it is cultivated very extensively in the north of China, and it also grows in the Himalayas. In China it is compressed for the sake of its oil, and the residual cake is used for food, and also extensively as a manure. In Japan it is used in the preparation of *shoyu*, and *miso* (sauces), and *töfu*, and also of *yuba*, and in these various forms enters, to a considerable extent, into the food of the nation, to which it is a most valuable contribution, supplying, as it does, the alimentary principles, albuminoids and fats, in which the staple food, rice, is deficient. Of late years this bean has been grown experimentally in different parts of Germany with success. The following is the method of preparation in Japan:—The yellowish white beans are soaked in water for twenty-four hours, or a night and a day, when they are poured into a stone mill and ground; as the quality of the product of manufacture is largely dependent upon the purity of the water used, it is necessary that the purest water obtainable should be employed. The beans having first been pounded, are mixed with an equal quantity of water in an oblong tub, and gradually poured into the orifice in the upper stone of the mill with a copper dipper. This mill, resting within a bottomless tub about eight or ten inches in height upon a narrow wooden stand, is turned round by means of a bamboo rod or handle, which has one end inserted into a socket in the upper millstone. The thin pulp of ground beans and water, as it flows from between the stones of the mill, is directed into a tub beneath, and kept from running along the horizontal bars of the table by the perpendicular sides of the bottomless tub which surrounds the mill. The pulp, which is collected in the tub beneath, is put into an iron pot and heated over a wood fire until it begins to boil, which stage is indicated by the appearance of bubbles or foam upon the surface. One or two gills of cold water are then poured around the edge of the inside pot, and as soon as the foam has subsided the pot is covered, and a second boiling takes place; cold water is then again poured in, and the contents allowed to stand. In stirring and mixing the pulp in the pot a kind of brush, made of split bamboo and coated with thickened oil, is employed. The pulp is then taken out of the pot with a ladle of bamboo, and placed in a grass-cloth bag, and to prevent it running over a kind of flat wooden trough is used. A small quantity of water is then poured into the bag, the mouth of which is tied up, and the whole laid upon a mat of sticks, and upon a linen cloth stretched over the top of a shallow tube. Pressure is then brought to bear upon the bag by means of a round wooden stick used as a simple lever, the liquor which oozes out filters through the cloth laid over the top of the shallow tube into the vessel beneath. If the quantity of pulp ground is large, several bags are necessary. The contents of the tube, being the liquor expressed from the grass-cloth bag containing pulp, is then stirred up with a little brine, and the cloth cover replaced. The cloth is again removed after the lapse of a few minutes allowed for the brine to thoroughly mix, and a further quantity of brine is then poured in. When coagulation takes place in the filtered liquor in the tub, a shallow bamboo basket, containing a stone to keep it down, is twice let down into the liquor, and the water which runs into the basket is removed. When coagulation is complete, the bamboo basket is inserted, and the tub tilted to one side, to allow the water to drain off through the meshes of the basket. To remove the coagulated substance from the tub, a wooden frame is used, which just covers the edges of a rectangular box, and a large cross-shaped piece of linen, having four flaps, is let down into the box through the orifice of the frame, so as to allow the four flaps to hang over the sides of the frame and box. The substance is ladled into the box until it is full; a mat, made of split pieces of wood bound together with a string, and which just fits the orifice of the frame and box, is placed upon it, and a wooden cover is then placed upon the whole. This cover consists of one flat piece of wood, fitting the frame, and provided with two flat pieces of wood upon the narrow sides crosswise, and upon them two narrow strips of wood running longitudinally with the cover itself and across the flat pieces, bearing upon them a heavy stone. Here are also four short pieces of wood, which, placed across the ends of the forming box, hold the longitudinal bars of the cover as they come down under the weight of the stone upon them, the water thus expressed flowing through the lining eloth and out of the perforations in the sides and bottom of the forming-box. The relations of the cross-pieces and the longitudinal bars with each other are such, that the pressure of the stone upon the cover is relieved by the side blocks whenever the level of the *töfu* in the forming-box sinks to that of the top of the box. The box with its contents are then placed in a large trough of water. After standing a little while to allow the *töfu* to cool, the box having been inverted is removed, leaving the coagulated substance behind. After taking off the cloth filter, the *töfu* is cut up with a broad-bladed brass knife into thick slabs. The quantity of water and brine used in the preparation of *töfu* is in the proportion of 15 *sho* (the *sho* being equivalent to about three imperial pints) of water, and half a *sho* of brine to 4·5 *sho* of the bean. *Töfu*

may be prepared in many ways for the table, such as by frying or toasting or making into soup. When fried or toasted it has, says the United States Minister, the taste of sweetbread, and when saturated with Japanese *soy* is not unlike that dish in appearance and consistency. When used in soup it is cut up into little squares. *Tōfu* and the residue in its manufacture are used for various other purposes, such as in the imitation of *tsuye-shu*, a kind of vermillion. For this purpose *tōfu*, from which the water has been expressed, is mixed with a kind of red lacquer with a spatula, and thoroughly kneaded. The warm water in which the beans are first boiled is used to extract grease from clothing, and to cleanse the mats used upon the floors of Japanese houses, and also for washing the ceilings. The pulp remaining in the grass cloth after the vegetable caseine has been expressed is used by the Japanese women as a substitute for soap in washing the hair. It is also used, when mixed with finely chopped straw, a sa food for horses, and sometimes as manure.

INDIAN TEA.

It appears, from Messrs. Gow, Wilson and Stanton's Report, that between November 19 and December 3, 50,003 packages of Indian, Ceylon, and Java tea has been offered in public auction. This amount being made up as follows:—Indian 44,340 packages, 3,958 Ceylon, 1,705 Java.

In analysing the figures given below, it will be noticed that notwithstanding an increase of more than 1,500,000 in the deliveries of Indian and Ceylon teas, during November, over those of the corresponding period of last year, the deliveries of China descriptions have remained stationary. Again, for the six months ending November 30th, the consumption of Indian and Ceylon teas shows an increase of 8,000,000, against an increase of only 4,000,000 in China descriptions.

The deliveries of Indian tea in November, exceeded those of October by more than 500,000 lbs., whilst those of China tea decreased almost 3,000,000 lbs. in the same time.

The amount of Indian and Ceylon teas offered in public sales during the past six months exceeds by nearly 100,000 packages the quantity offered during the corresponding period last year.

Movements (in lbs.) of tea during—

November, 1886.

	Imports.	Deliveries.	Stock.
Indian	11,360,028	7,158,468	25,318,860
Ceylon	499,750	566,240	1,601,350
Java	197,330	241,710	967,820
China	9,215,854	12,035,295	67,260,019
Total lbs..	21,272,962	20,001,713	95,148,049

November, 1885.

	Imports.	Deliveries.	Stock.
Indian	7,724,058	5,830,746	20,765,754
Ceylon	259,750	266,150	994,390
Java........	126,210	278,250	566,790
China	9,790,860	12,008,300	69,656,552
Total lbs..	17,900,878	18,383,446	91,983,486

1st June to 30th November, 1886.

	Imports.	Deliveries.	Stock.
Indian	38,541,028	33,899,468	25,318,860
Ceylon	3,926,750	4,190,240	1,601,350
Java........	1,856,330	2,119,710	967,820
China	104,225,854	75,437,295	67,260,019
Total lbs..	148,549,962	115,646,713	95,148,049

1st June to 30th November, 1885.

	Imports.	Deliveries.	Stock.
Indian	34,052,346	27,567,504	20,765,754
Ceylon	2,341,760	2,083,510	994,390
Java	1,603,210	1,983,250	566,790
China	95,760,860	71,361,300	69,656,552
Total lbs..	133,758,176	102,995,564	91,983,486

MIDDLE-CLASS EDUCATION IN RUSSIA.

Under the term middle-class schools are understood in Russia, gymnasia, progymnasia, cadet schools, trade schools, theological schools, and private educational institutions belonging to the churches of unorthodox confessions. The United States Consul-General at St. Petersburg says that at the beginning of the nineteenth century there were, in all Russia, but three gymnasia, or grammar schools, one at St. Petersburg, one in Moscow, and one in Kazan. Since that date they have, however, multiplied a hundredfold. In 1838, the number of gymnasia and similar educational establishments was 56, the teachers numbered about 800, and the pupils less than 8,000. Half the teachers were without any academical education, the directors were retired officers, and at the examinations, influences, other than the pupil's knowledge, prevailed. In the plan of instruction the natural sciences prevailed over the classics. There were in the month 32 lessons in Latin and German, and 86 in mathematics, physics, natural history, technology, natural and international law, history, geography, political economy, commercial science, and drawing. Count Ouvraoff, who presided over the Ministry of Instruction from 1833 to 1849,

opposed this tendency, and expunged from the plan of instruction technology, political economy, &c., substituting for them religion and Russian, and made the dead languages the foundation of gymnasial education. The number of gymnasia rose to 76, and that of the pupils to 20,000. In 1849, a great reaction set in; classical education was regarded with suspicion; the idea gained ground that the study of the natural sciences would produce more moderate men, and consequently better subjects. In most Russians there appears, says Consul Stanton, to be a singular impression that their nation is destined to a most special course of mental development, that they do not need classical education, and that they can advance without labour. When in opposition to these pretensions, Alexander II. agreed with his Minister of Instruction, Count Tolstoi, that Russia was not destined to develop new courses of mental culture, but, on the contrary, must pursue the routes that nations of older civilisation had followed, the Government experienced the most violent opposition. It appears that, even at the present day, most of the professors of the gymnasia are bitterly antagonistic to the friends of classical education. Since 1867, the reform of the middle-class schools has begun in earnest. Since that date there is no other way open to a university than through a gymnasium, of which classical historical studies form the basis of its construction. In 1880, there were 205 gymnasia, and 71 ordinary schools; that is, one gymnasium to 400,000 inhabitants, and one ordinary school to every 1,125,000 of the population, and more than half these schools are Government institutions. In 1876, the estimate for middle-class schools were 6,500,000 roubles; in 1884, they amounted to 9,200,000 roubles. Of these schools there were, in 1880, in the two capitals, 29 for boys, and 24 for girls; in 45 provincial cities and Odessa, 94 for boys, and 56 for girls; and in 437 district towns, 91 boys', and 152 girls' schools. These numbers include not only gymnasia and commercial schools, but all middle-class educational institutions. The number of scholars from 1866, when there were 98 schools, to 1876, when there were 240, increased from 20,000 to 50,000, whilst in the same period the number of university students did not amount to more than 5,000. Classified according to religion, there were in the gymnasia, in 1871, 25,719 orthodox Russians, 10,500 Catholics, 3,363 Protestants, 92 Mohammedans, and 3,016 Jews and Armenians. The classification, according to social position, is as follows:—Sons of nobles or officials, 25,461; sons of priests, 2,006; sons of merchants and tradesmen, 11,929; sons of peasants, 2,455; and sons of foreigners, 661. The participation of the female sex in the instruction of the middle-class schools in Russia is unusually great. There are 30 female foundations, and over 200 gymnasia and pro-gymnasia for girls, and their lecture-rooms are said to be never empty.

Obituary.

Sir Douglas Forsyth, C.B., K.C.S.I.—Sir Thomas Douglas Forsyth, who died at Eastbourne on Friday, 17th inst., after a short illness, was born in 1827, and educated at Rugby and Haileybury. He went to India in 1848, in the civil service of the East India Company, and was first appointed Assistant Commissioner in the Punjab, and afterwards Deputy Commissioner, which latter office he held from 1852 to 1856. He held office at Umballa in 1857, at the time of the Indian Mutiny, and he was made a C.B. for the active part he took in the suppression of that mutiny. In 1870, he was sent on a mission to Yarkand, in Eastern Turkestan, by the Governor-General of India, Lord Mayo, and in 1873 he went as envoy to the ruler of the country, to negotiate a commercial treaty, which he succeeded in getting signed, and for this service he was made a Knight Commander of the Star of India. In 1875, he was appointed envoy to Burmah. Sir Douglas Forsyth read a paper on the "Progress of Trade with Central Asia," before the Indian Section of the Society of Arts, in March, 1877, and for this paper he received the Society's medal. He held the office of Vice-President of the Society from 1878 to 1881, and took the chair on several occasions at the evening meetings.

General Notes.

Royal Institution.—Professor Dewar, M.A., F.R.S., will deliver the Juvenile Lectures on "The Chemistry of Light and Photography," at the Royal Institution, on the afternoons of Tuesday, December 28th, Thursday, December 30th, and Saturday, January 1st, 1887, at 3 p.m.

The Swiss Silk Industry.—The Zurich statistics for 1885 show a reduction since 1883 in the number of firms engaged in the various branches of the silk trade from 136 to 119, while the number of workpeople and *employés* has fallen from 50,396 to 39,084. The Silk Association of Zurich attributes this decline in part to the protective fiscal policy of various countries hitherto customers of Switzerland, and partly to the growing competition of power-loom weaving, to resist which notable improvements are required in the hand-loom. The increase of power-looms has only been from 4,007 to 4,129, so that Switzerland has not kept pace with other countries, and this slight increase has not by any means counterbalanced the decadence in the hand-loom industry.

Journal of the Society of Arts.

No. 1,780. Vol. XXXV.

FRIDAY, DECEMBER 31, 1886.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

JUVENILE LECTURES.

The first lecture of the usual short course adapted for a juvenile audience will be given by Professor A. W. Reinold, F.R.S., on "Soap Bubbles," on Wednesday next, January 5th, at seven o'clock. The second lecture will be given on January 12th.

All the tickets for these lectures having now been disposed of, the issue is stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Two Gold Medals and Four Silver Medals for prime movers suitable for electric-light installations.

The medals will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class.

(A.) Motors in which the working agent is also produced (steam and gas engines).

(B.) Motors in which the working agent must be supplied (steam, gas, and hydraulic engines).

Each class will be subdivided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p.

The entrance fee will be £2 10s. per h.p., to be paid on entry.

The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

The full statement of the conditions under which the medals are offered can be obtained on application to the Secretary, and will be found in the number of the *Journal* for December 17.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

PRINCIPLES AND PRACTICE OF ORNAMENTAL DESIGN.

By Lewis Foreman Day.

Lecture II.—Delivered December 6, 1886.

The Distribution of Ornamental Design.

In my last lecture, I undertook to lay down the lines upon which repeated pattern-work could be constructed—to show, that is to say, the comparatively simple plan on which the manifold forms of surface ornament are built up, and the very limited range of lines on which pattern can be built.

This evening I propose to discuss the lines on which ornament (not necessarily repeated) can be distributed. And I think it will not be difficult to show that, illimitable as those lines may at first sight appear to be, they too allow themselves to be classed pretty definitely; and, moreover, that the classes are not by any means so numerous as might be supposed.

The first thing one has to do in designing is to determine the lines on which the design shall be distributed—to plan it, that is to say. The more clearly the designer realises to himself the lines on which it is open to him to proceed the better; and if it can be shown (as I think it can) that these are, comparatively speaking, few and simple, so much the easier will it be for him to make up his mind promptly and determinedly which of them he will in any

case adopt. The shape of the actual space to be filled will oftentimes determine for him, more or less, the distribution of his design. That is to say, it may very likely render certain schemes altogether unavailable, and perhaps even limit his choice to a single plan; but at his very freest he is limited, in the nature of things, to certain methods of procedure which I shall proceed to define.

Obviously, it would be out of the question to discuss at length the relation of every possible plan to every possible shape. I purpose, therefore, to take the simple parallelogram (which may stand for panel, page, floor, ceiling, carpet, curtain, shawl, window, door, façade, no matter what), and to show the possibilities with regard to the distribution of ornament over its surface; and then to explain how the same principles apply, no matter what the shape to be filled.

Given a panel to be filled then, what is to be done? There are two very obvious ways of going to work, either of which, to the sophisticated modern at all events, seems equally natural. You may start from the centre or from the edge. That is to say, you may occupy the field or centre as seems good to you, and work outwards to the margin; or you may begin with a border, and work inwards. The border once defined, the space within remains to be treated. In fact, theoretically, we have only reduced the area over which our composition is to be distributed. But practically that is not quite so, more especially if the border be of any importance. A border may be of such interest that nothing further is needed, and the centre of the panel is best undisturbed by ornament. Especially may this be so if the material in use be in itself of some interest. It is distinctly not desirable to mar the surface of beautiful wood or richly varied marble with added ornament. And pretty generally in woodwork (unless we wish for once in a while to be ultra lavish of enrichment) it resolves itself into a question of whether we shall enrich the panels or the mouldings bordering them.

If you adopt the idea of a border, the simplest and most obvious thing you can do is to keep it of one uniform width on all sides. And it makes all the difference (as I have already hinted) whether it is simple or elaborate in character. A very deep rich border has such an entirely different effect from a moderately simple one, that it looks something like a different treatment altogether. Borders may be so schemed (and should be so schemed) as to give panels of proportions suitable to them. If, for instance, a panel is to be filled with a diaper, arrangement should be made for the "repeat" of the pattern within it. If it is to contain a figure or a figure subject, it should be of a proportion and size not too difficult to occupy with a figure or figure subject.

In the case of an isolated panel, this is perhaps of less importance—the artist ought to be equal to the occasion—but in the case of a series to be treated in accord, the problem is made infinitely more difficult when the panels are of all manner of shapes and sizes.

There is a salon in the palace at Fontainebleau in which the proportions of the panelling prove to be due almost entirely to the painter, who has brought the larger panels into scale with the smaller by means of a series of borders within the actual mouldings. It is much less trouble of course for the joiner, when he has an awkward space to panel, to fix the width of the stiles, and let the panels come as they may. But a very little consideration on his part would save the decorator, who comes after him, an infinity of pains.

The stiles which frame a panel may be considered as a border; the mouldings again are so many borders within borders. A border which is made up of many lines really constitutes a series of borders one within the other. The use of border within border as a deliberate means of ornament is common enough. You may even add border to border until the whole field is occupied, as was the case in certain tooled bookbindings of the 17th century, and in Fig. 10 (p. 107).

Equality of width is by no means essential to a border. You see in many Mediæval illuminations the effect, more or less satisfactory, of emphasizing two sides of the page. Nor need the border necessarily be continued all round the space at all. Curtains have often a border on two sides only, and sometimes only on one, marking what one may call the lips of the hangings. You may look upon the architrave of a door as a border on three sides of it only. And in the same way a mantel-piece partly frames the fire-grate. Every frame is a border; no matter how irregular the shape of it may be, a frame 's a frame "for a' that." It may take the architectural form of cornice, pilasters, and dado, or it may be arched, and in either case the architectural members are but unequal borders. You will see, of course, how all this applies not only to an architectural picture

frame, but to architecture itself, and to things in general.

Something like a new departure occurs when the border, so to speak, *invades* the field or centre of the panel, as it very often does in French Renaissance work, sometimes to such an extent that little or no further decoration of the field is necessary. In some of the interlacing strap work of the Henri II. period (the French equivalent to our Elizabethan ornament), you cannot always clearly tell where the border begins and ends, or even whether a border was intended at all. It looks sometimes as if the designer had started with the idea of a border, but had allowed it so to encroach upon the field, or the field upon it, that in the end it is not at all clearly recognisable as such. Fig. 11 illustrates the kind of thing I mean.

FIG. 10.

Nearly allied to this is another kind of border, also devised so as to be quite inseparable from the filling; in which, in fact, frame and filling are so ingeniously mixed up that, but for the emphasis of colour, the effect would be confused.

It is interesting to notice the difference between this method and the practice of the Japanese, who will, in the most unhesitating manner, allow the filling pattern, whatever it may be, to break over the margin or border, just as the impulse prompts. This is a proceeding which may or may not result in confusion, according to the relative strength of the border and the pattern that cuts across it. One appreciates this kind of freak as a relief from the monotony of absolutely formal disposition, but it is not a thing to indulge in very freely. It is refreshing to see that a man is not afraid of infringing occasionally upon the margin, on sufficient grounds; but it needs always to be justified by some excuse other than the artist's impatience of order. There is no special sanctity in a margin that it should be held inviolate, but order is essential to ornament. We have to beware of a certain spirit of anarchy which appears to have taken possession of so many a modern artist. There is a class (one cannot call it properly a school) which will repudiate not only all the laws of art but the need of all law whatsoever. Urgent need there may be of reform in our ideas of art, perhaps even of revolution; but we are justified in refusing to recognise in the artistic anarchist anything but the enemy of art.

FIG. 11.

There was a fashion in vogue in the 17th and 18th centuries—borrowed probably from the East—according to which the border is

invaded in a somewhat formal way by the field or ground, rather than by the filling pattern; where the field, in fact, seems to eat into the border. It is usually rather a symmetrical mouthful that it takes.

A border may be lost in a sort of confusion with the panel it began by pretending to enclose. No one ever did that kind of thing more cleverly than Boulle. But a border remains a border, however undefined. The boundaries may be understood rather than expressed. Yet that makes no difference as to the lines upon which the design is constructed. You may say to yourself that you dislike formality, and that you will have none of it; you will merely sketch upon your page such and such marginal forms, natural or ornamental. But if you dispose them in anything like an orderly manner, you arrive at something which comes as clearly under the category of border treatment as though it had been enclosed by hard and fast boundary lines.

And every margin or marginal line is in its degree a border. In Indian and other Oriental work you often see the ornamental details so closely packed as to define the border-shape even without actual boundary lines. And the Germans of the 16th century (Jost Amman, for example) sometimes did with very different details just the same thing. The looser borders of Louis XIV., XV., XVI. do the utmost they can to hide the lines of their construction; but it is a sign of weakness, I think, to be afraid of a straight line. So great is the use of the border, that even those who least like formal lines are bound to adopt it, although they are always rebelling against its formality, and doing their best to break it up, as in the case of the encroaching and interrupted borders already mentioned.

The very *naïvest* way of getting over the difficulty—it is a difficulty, and a serious one—is by, so to speak, snipping a piece or two out of the panel, and carrying the border round the incisions, so as to get a more or less irregular central space instead of the four-square parallelogram. In the Certosa at Florence, there are some windows by Giovanni da Udine, in which he has deliberately snipped pieces out of the space to be filled, and left them as so many gaps in the design. One may forgive this kind of thing once in a way, but it stands very much in need of justification. Where the gap has some meaning it is different. In the case where there is a square block or patera occupying the corner, for instance, as you sometimes see in 17th century wood-panelling, that seems to account for the break in the border. Nor is there any objection, that I see, to the doubling of the border round an imaginary line; by which means the same end of irregularity is arrived at without the brutality of da Udine's method. The artists of the Renaissance, and of the later Renaissance in particular, were too ready to adopt any device which would enable them to depart from the simple panel form. In not a few instances, the further they went from it the worse it fared with them.

Much might be said about the construction of the border itself. It may be continuous or broken, and broken at all manner of intervals, and in all manner of ways. It may flow or grow. It may be symmetrical or absolutely free. The outer or the inner edge may be accentuated, or both, or neither. It may spread outwards from a well-defined central feature or inwards from the margin, diffusing itself, and giving a less definite central shape; but it is not so much the design of the border that we are considering at present, as the place of the border in design.

Though you abandon all idea of bordering, and elect to place, as you well may, some arbitrary shape within the parallelogram, still the space round about that shape may be considered as an irregular border to that shape. If, for example, you plant in the centre of the space a medallion, and round that medallion a cartouche, the cartouche may be called the frame or border of the medallion; and, again, the ground beyond the edge of the cartouche may be taken to be the margin or border to that. In such a case we have arbitrary shapes, one within the other; but one might just as well have two or more such independent shapes. Nothing is easier than to take a simple field, and to spot about upon it any shapes you please. That is one way, not a very ornamental way, but one way, of occupying the space. But if you proceed to connect those shapes in any way, you bring in another principle of design—which, however, will be more conveniently approached from the other side, when we come (as we presently shall) to the discussion of the lines enclosing various shapes and subdivisions. Abandoning all thought of border, or supposing a border already in existence, you may, as I said, plant any independent shape, medallion, shield, cartouche, tablet, what you will, within it. This form may be left, as it were, floating in space; or it may be supported by ornament; which ornament may literally seem to hold it

up, or, if you will, the ornament may appear to be suspended from it, as was the case with the festoons and garlands of the later Renaissance. Finally, such ornament may be unconnected with the central shape, and comparatively independent of it, as a diaper would be.

The central feature need not be an enclosing shape ; it may be an ornament, a figure, a spray of flowers, a vignette, a spot, a sprig, as free and independent as a voter who knows no party; or, just as in the case of the closely-packed border, whose shape was marked without the aid of boundary lines, so the central sprig of ornament or foliage may be so densely massed within an imaginary square, circle, quatrefoil, or other imaginary form, as to assume a quite regular outline.

If you introduce a number of features, free or formal, they group themselves into a sort of diaper over the surface. And this diaper should naturally have some reference to the space it fills, or it will appear less than trivial. Whether such sprigs be all alike, or of various design, is a question independent of the lines of their distribution.

A mere series of bands or stripes across the field (vertical, horizontal, diagonal, waved, or in whatever direction). is an obviously simple way of getting over the ground, about which nothing further need be said. Any scroll, or other more important ornament filling, may be quite free, or disposed symmetrically in relation to an imaginary central line or spinal cord ; or it may radiate from the centre, as it naturally would in a ceiling, pavement, carpet, or other object demanding an all-round treatment.

Such scroll work, or what not, might equally proceed from two ends of the panel, or from the sides, or from both, either symmetrically or at irregular intervals ; or it might spring from the corner or corners. The treatment from the corners is again adapted to, and adopted in, ceiling decoration. In principle it is very right indeed, but in practice it is not invariably all that a decorator could desire. The "line and corner" tune, as it may be called, has been harped upon until one is heartily sick of it, even when it is played in time, which is not always the case. A cornerwise treatment is seen to advantage when it has been suggested by use, as in the metal garniture of old book bindings, and coffers such as the German smiths of the 15th and 16th centuries delighted to elaborate. These same book-covers and caskets afford excellent examples of a treatment where the design is manifestly "to be continued in our next," the side unseen being necessary to its symmetrical completeness. The need of clasps, hinges, &c., no doubt gave the hint of such a manner, which, in spite of the one-sided forms it gives, is eminently satisfactory in effect. We scarcely realise how readily the mind makes good what the eye does not see in design.

It is worth while to compare this symmetrical scheme (in which the symmetry is suggested rather than expressed) with the free and easy way in which the Japanese lacquer-worker will overrun the limits of a box top or cabinet front, and trail his ornament over all or any of its sides indiscriminately. Here, too, the artist, in his very different fashion, chooses to consider the whole object his field, and not just the part of it he sees before him. There is a certain logic in his licence, but the more restrained manner of the Mediæval workman is, in proportion to its restraint, the more to be preferred.

Where the design—scroll, foliage, or whatever it may be—bears no relation at all to the shape or space it occupies, it ceases to be surface design, and is merely a means of breaking the surface. It is only as a background that such haphazard forms have any meaning.

A very satisfactory and effective result is sometimes obtained where the artist starts, as it seems, with the idea of a diaper, more or less geometrical, and, as he approaches the centre of the panel, gathers together the pattern, so to speak, into points of emphasis. Designs of this kind were unmistakably first set out in geometric divisions, certain of which divisions were afterwards grouped together to give point to the pattern.

The difference between this way of focussing the design and the plan adopted in Fig. 11 (page 107) is, that there the central shapes appear rather to have suggested the corresponding interlacements than the interlacements to have led up to them. But even in such a case it seems desirable that the artist should have in his mind from the beginning some kind of idea of geometric construction. The longer he can manage to keep that geometric notion in his mind without putting it on paper, the more freely he can go to work. That faculty of holding a design, so to speak, in solution in the mind, is most invaluable to the designer; it is so much more manageable in its fluid state. Once it is allowed to crystalise into definite shape, it is no easy matter to modify a notion.

If the space to be decorated be very considerable in extent, it is often necessary to cut it up into sections otherwise than by merely marking off a border. A wall, for example, is divided into cornice, frieze, wall space, dado, and so on. Or it may be divided vertically into panels of equal or unequal width. A building in several storeys is an instance of the one kind of division, a colonnade of the other. If the subdividing lines take both directions, the result is a scheme of panelling, such as was commonly adopted in the domestic woodwork of the 16th century.

Further, by the introduction of cross-lines at various angles, or of curved lines, we arrive, by a different road, at panelling of more complicate character, and at something like the interlaced patterns to which reference has already been made. It is clear that these various ways and means may be associated; and, under the complex conditions of the times, they usually are more or less "highly mixed."

Thus one may, as I have said, begin with a border, and then treat the space within it in any of the ways already described; one may divide a wall horizontally into two, with a diaper or frieze at the top, and panelling below; one may plant upon the field any independent feature, frame, shield, tablet, or such like, and then fill in the background without regard to it, as though a portion of the design were lost behind it. As many as three or more plans may be associated. For example, one might stretch across a title page a tablet (Fig. 12), then introduce a border disappearing behind; and the spaces enclosed between the border and the top and bottom of the tablet one might treat again as independent panels.

The idea of overlaying one ornamental feature by another, was adopted pretty generally by the Early Gothic glass painters, who would start with a series of important medallions (probably with figure subjects), behind which they would scheme a series of less important medallion shapes, and behind these again a border perhaps. Such a scheme affords considerable scope in design.

The use of the border is not, of course, confined to the outer edge of the main space to be filled. Each sub-section of the design may be provided with its own border, as you see in the case of panelling, where each separate panel has its own border of mouldings. So again a central feature may have its border or borders interlacing with, or intercepted by, the borders which mark the space or panel itself. A space or panel once sub-divided, as already described, it is open to the artist to accept each compartment as a separate panel, designing his ornament into it; or, with equal reason, he may make his ornament continuous throughout; allowing it, that is to say, to run behind the dividing lines or to interlace with them. Again, the two plans may be combined, certain prominent parts being reserved for individual treatment, and the subsidiary spaces being connected together by the forms of the ornament. Which of the two may be the better plan to adopt is a question of some nicety, not always easily to be decided. In proportion to the importance of the framing lines it becomes

FIG. 12.

dangerous to overstep them. Who ventures nothing runs no risk of failure, but neither will he achieve any great success in art. And then there is the charm of danger. Soldiers, sportsmen, and mountaineers, are not the only class of persons privileged to run a risk. It is a luxury we may all indulge in on occasion—were it not so art would be no congenial pursuit for any one who is really alive. Only a man should look before he leaps into danger. Count Moltke's motto puts it very pithily, "Erst wägen, dann wagen," which might be paraphrased "Weigh before you wager."

When the artist starts from the beginning,

and the design is entirely in his own hands, it is not so difficult to determine just what is fit. But in the more frequent case, in which the art of the ornamentist is only supplementary, and he has to work upon lines already laid down for him, it is only where those lines are worth preserving that he is necessarily bound to preserve them, assuming, that is, that he can obliterate them. This is heterodox, but I hold it true. If the lines existing are bad, and the artist can by his design withdraw attention from them to lines more reposeful to the eye, he is doing good work. But he should do nothing but what he can make seem right. There must be no appearance of awkwardness, no suspicion of effort about it. It is a case in which success alone justifies the attack upon the situation. To fail is to lay yourself open to the charge of the unpardonable sin, the sin of disobedience to the conditions of design.

An actually haphazard or eccentric scheme of composition, such as a Japanese will sometimes affect, is hardly in contradiction to what I have laid down. When a Japanese artist cuts a panel quaintly into two, and treats each part of it as seems good to him, he is only doing what the Greek did when he cut off a portion of his wall space, and treated as a frieze — only he does it more energetically, not to say spasmodically, and with less appreciation of grace. So, again, when the Japanese begins with discs or crests dotted about on no perceptible plan, and strews sprigs of bamboo between, he is only doing in a more eccentric manner what the Western artist does, with greater regard for symmetry, when he disposes his sprigs on a geometric basis. If only he arrive at balance, which he almost invariably does [his instinct in this respect is so little likely to err] there is no occasion to cry out against him. We, on our part, are perhaps too much disposed to design as though there were no possible distinction between weight and bulk—as though the little leaden weight did not balance the heaped-up pound of fruit, or feathers, or whatever it may be.

Design apparently unrestrained, such as the men of the Renaissance habitually indulged in, proves very often, upon examination, to be constructed upon one or other of the systems I have described. Sometimes, indeed, the system of construction is very frankly indicated, though not precisely defined. At all events, the confession is full enough to ensure absolution for any offence there may be against strict order.

The scope of sub-division possible with regard to a space is not affected by the amount of ornament introduced or its character. No matter whether it be human or animal figure that you employ, conventional or natural foliage, scroll or growth, interlacement, arabesque, or geometric pattern, the possibilities in the way of distribution are the same.

Naturally, however, certain lines of subdivision will be found to accord with certain kinds of treatment; and so we find that, as a matter of history, the Mohammedans adopted certain lines of composition, the Greeks other lines, and the Japanese quite others again. Furthermore, the lines one would instinctively choose for different purposes would themselves be different. One would scarcely proceed to decorate a panel by merely crossing it with bands of ornament, except perhaps in the case of some long strip of a panel which it was absolutely necessary to shorten; but that is just what is suitable to the shape of certain vases; and the Greeks found it the most satisfactory way of dealing with draperies. Their pet idea of decorating a full skirt seems to have been by means of a series of parallel patterns. If you refer to the vases at the British Museum, you will see both of these uses illustrated, often in a single vase.

What one would do, then, is not the same thing as what might be done. The possibility, as distinguished from the suitability, of distribution, is in all cases much the same, but there must necessarily be some correspondence between detail and its distribution. For all that, there is no cut and dried rule as to the association of this kind of detail with that kind of distribution, or *vice-versâ*. It does not even follow that the kind of detail usually found in connection with a certain kind of composition is the only one appropriate to it. The connection of the two is evidence only of their conformity, not at all of the incongruity of other combinations. You may fry without bread crumbs. It is chiefly laziness, if it is not a suspicion of our own incompetence, which tempts us to adopt bodily what has been found to succeed. There are so many people in the world to whom it comes easier to take what is there than to give what is theirs.

A design is in harmony not when it is strictly according to Greek or Gothic precedent, but when the parts all fit. Suppose, for instance, the lines lead up to some prominent feature, that feature must be of sufficient

interest to justify the attention called to it. There are positions so prominent that they call almost for figure design to occupy them. So, also, if it is proposed to introduce the figure, or anything of that importance, it is only natural to provide for it in your scheme, whether in the shape of medallion, frame, niche, or what not. The gem of your design should have a setting worthy of it.

Instances of such framing occur in diagrams on the walls. I don't mean to say that a coat-of-arms is essentially of profoundest interest; but in the eyes of its owner it is at least worthy of all prominence.

Any feature such as a tablet, medallion, label, cartouche, shield, and so on, introduced into a composition, should bear relation not only to its surroundings, but to what it is to enclose. This is a serious consideration very often neglected. It is no uncommon thing to see a shield introduced to bear an inscription, a circular medallion to frame a picture which demands a rectangular outline, and all manner of queerly proportioned shapes, which by their very position call for decoration, whilst, at the same time, it is almost impossible to fill them satisfactorily.

Upon the same principle of fitness, a predetermination to adopt natural forms of foliage would, artistically speaking, necessitate the choice of a not too formal framework for it; whilst detail designed on a large scale would call for equal breadth and simplicity in the setting out. So also with regard to the allotment of ornament—once the lines determined, the artist must scheme his ornament accordingly. Whether he elect to ornament every portion of the surface, as the Orientals often do, or certain selected parts only, like the Greeks, whether he chose to decorate many parts or few, and which parts, and how—that is his affair. His taste must be his guide in that, and unless he have some taste, he had better not attempt to design. This may sound like discouragement; but since the beginner in design is the last person who would be disposed to admit any arbiter in the matter of taste, the warning is not likely to deter anyone from trying his hand at ornament. It is so easy, you know!

So far my remarks have been confined to the discussion of the panel shape, or parallelogram; but, as I began by saying, I have no idea of making that the limit of our consideration to-night. I think I shall be able to show, without much difficulty, that the principles upon which all manner of shapes may, and indeed must, be filled, are much the same. Evidently it makes little difference at all, and in principle none whatever, whether it is four sides of a figure we have to deal with, or three, or five, or how many. In either case you proceed in the same way; you work from the centre or from the sides, as best may suit; you divide the space into regular or irregular compartments, on the system already explained; you overlay one feature with another, or interweave them; you interrupt a border, or invade a centre, according to the circumstances of the case; and so on, just as though it were an oblong you were dealing with.

If it is at all an awkward shape that has to be treated, you have even an opportunity of correcting it, by introducing into it some prominent regular figure which, if you insist upon it, will occupy attention, whilst the irregular surrounding space will go only for margin or border; just as in the case of the regular panel you had the option of discounting its severity through the agency of any irregular feature that seemed good to you.

The management of the circular shape, and of the irregular forms of vases, seems to present a more serious difficulty, which, however, is more apparent than real. A vase is easiest decorated according to its elevation or according to its plan. Any striped Venetian glass affords a type of the one proceeding, any ringed clay vessel of the other. The glass blower arrives as naturally at the one as the thrower or turner at the other.

Another way is to cross the shape diagonally, which results in the appearance of twisting, as may be seen very often in silversmith's work. Of course these systems may be associated, and they often are, as in the German tankards of the 15th century, where the bulbous bowl is beaten out into the semblance of a melon, and the neck and foot are simply turned.

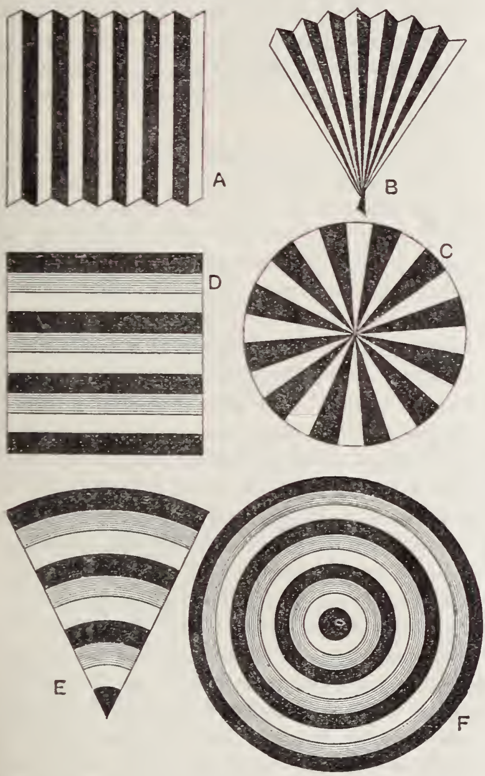
Now the decoration of a vase lengthwise, according to its elevation, corresponds to the striping of a panel with vertical lines; the decoration bandwise, according to plan, corresponds to the striping of a panel with horizontal lines; and the twisted treatment corresponds to a series of diagonal lines crossing a panel.

The way in which medallions, panels, and other shapes may be incorporated with the design of a vase is not different from that already described. There is, however, this difficulty, that any marked independent shape is likely to interfere with the form of the vase, or the form of the vase to interfere with it, as

is the way with the landscape and picture medallions so persistently misapplied to Sèvres and Dresden china. Not that it is at all impossible to introduce such features with good effect; only it needs to be done with judgment, which of all things is most rare. And, as it happens, the difficulty has been more often attacked with valour than with that discretion which is reputed to be its better part.

The decoration of the circular plane involves new forms rather than new principles. The circle is most naturally divided either into rays or into rings. In the one case the radiating

FIG. 13.

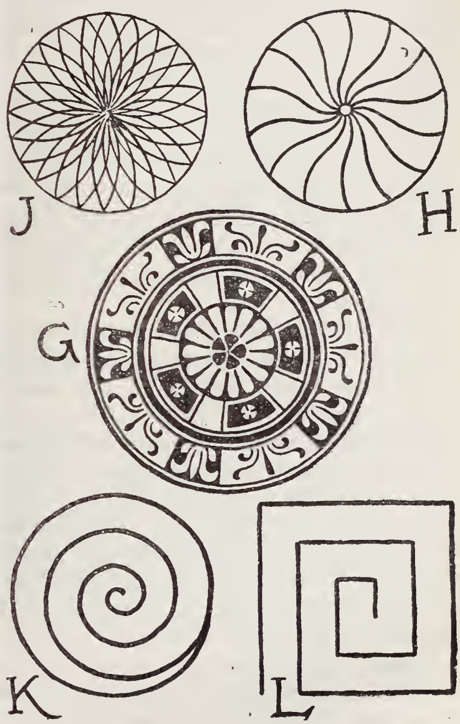


lines answer to the division of a rectangular space by vertical lines; in the other the rings answer to the horizontal lines dividing a panel. This is easily shown in Fig. 13.

Imagine a series of upright lines, A, to represent the folding of a sheet of paper. You have only to gather the folds together at one end, after the manner of a fan, B, and you have the system of radiation. Repeat the fan shapes side by side, and you soon arrive at a circle divided into rays, C.

Again, in the case of a series of horizontal bands, D, you have only to suppose them elastic enough to be bent, and you have a series of concentric arcs, E, so many slices, so to speak, out of a circle decorated ringwise, F. The same target-like result may be arrived at by the continuation of a series of borders round the circle, one within the other. That is only another way of reaching the same point in design. The crossing of the two schemes, G, is much the same thing as a square lattice of cross lines in a rectangular panel. The subdivision of the circular space by lines of more flowing character, H, would correspond to the division of the panel by diagonal lines; and if those lines were crossed, J, it would be

FIG. 14.



analogous to the division of the square by cross lines into diamonds. The spiral line, as applied to the decoration of the circle, K, is equivalent to the fret or key pattern as applied to the square, L. These analogies, I think, are plain enough.

All manner of independent shapes may be introduced into the decoration of the circle, as into that of the panel. One may plant a shield in the centre, and surround it with a border, one may associate any arbitrary form with ringed or radiating lines. But should any such shape form an important feature in the design, the situation is not so free from danger

There is a limit, that is to say, to the arbitrariness with which prominent lines or forms may judiciously be introduced into a circular design. Anything which counteracts the space you have to fill needs to be accounted for. The difficulty in dealing with forms contradictory one to another is that you are apt to leave interspaces of irregular shape which are not very manageable, as, for instance, in the inevitable spandril which occurs so frequently in architecture. If it happens to be very large you can insert into it a more regular shape, which will hold its own; and if it is insignificantly small, you may ignore it. You may (if it is of importance enough to be accepted as an individual panel) treat it as such, with figures, scroll, and so on. Or you may simply cover it with an unimportant pattern in the nature of a diaper. These are the extremes; but the happy mean in spandril decoration is not easy to find; and the spandril may be taken as the type of all awkward shapes produced by the intersection of curved lines with straight. Ornamental design would be a much easier thing if we had only to consider the lines of the ornament, without any regard to the interspaces.

From the decoration of the circle to that of the rosette is only a short step. What applies to the vase shape applies to the column, baluster, pedestal, and so on. The triangle offers no new difficulty; a branched form may be looked upon as an assemblage of familiar parts, the Greek cross, for example, as an assemblage of five squares. An altogether exceptional space will be pretty sure to indicate of itself the exceptional lines on which it can best be decorated, and a capricious one may well be left to the caprice of the artist.

Entirely apart from the question of the skeleton of your design, is the consideration as to whether it shall be looked at primarily from the point of view of line or of mass. In any satisfactorily completed scheme, lines and masses must alike have been taken into account; but the artist must begin with one or the other, and the result will probably be influenced by the one or other consideration which was uppermost in his mind. Which of the two it may happen to be, is more often a matter of temperament than of choice with him.

The primary consideration, whether of line or mass, will always lead the designer, though perhaps unconsciously, to adopt a plan accordingly—that is to say, the preference for mass will lead him to attack his panel resolutely, planting shapes upon it which it will be his business afterwards to connect by means of the subsidiary lines needful to the completion of the scheme. On the other hand, a greater partiality for line will induce him to have recourse to a more orderly procedure; will, perhaps, even suggest a geometric groundwork, which, however far he may depart from the first lines, will materially help him in securing the object he has most at heart.

If you start with certain arbitrary and irregular forms, so many patches, as I may say, on the panel, it is clearly not such a very easy matter to connect them by any systematic lines of ornament. If, on the contrary, you begin with some system of orderly lines, these must necessarily determine in some measure the shape and distribution of any more prominent features you may thereafter introduce into the scheme.

For my own part (whilst I disbelieve entirely in arriving at anything more than mediocrity by the adoption of set rules of proportion), I feel rather strongly that there should be by rights a strict relation between the parts of the design, however little it may be obvious. If, for example, there is a space to fill between border and central medallion, a diaper may be enough; but the diaper should be designed into its space. And even if part of a design be permitted to disappear, as it were, behind this feature or that, it should be so schemed that no very material form is mutilated in the process. Where an interruption occurs in a border the pattern should be planned with a view to such interruption. Even though you deliberately adopt a diaper as a background, the character of that diaper should be determined by the scroll, notwithstanding that the lines of the one are meant to contradict the lines of the other. It is not enough casually to employ any diaper. In the Early English glass to which I referred a while ago, the overlapping patterns were designed to overlap. The spaces between one series of medallions suggested the shapes of the minor medallions between, which were shaped with a view to interruption. The careless overlaying of one pattern, or of one scheme, by another is the merest makeshift for design.

You will find invariably that the apparently "accidental" treatment, when it is at all successful, is not quite so much a matter of accident after all. There has been no disregard of the laws of composition, but only the omission of some accustomed ceremonial. To take what might seem a flagrant instance

of the disregard of an obvious rule of art. There is a drawing on the walls of a cabinet by Boulle, in which the doors are treated as one panel, notwithstanding their actual separation by a pilaster between them. However wrong in theory this may seem, in practice it proves to be not so unsatisfactory. And for this reason—that the upright intervening space was, as a matter of fact, very carefully taken into account in the design. The artist chose to make it less emphatic than its position would have suggested to most of us it should be. But he did not really ignore it. Very far from it. Had he disregarded the construction, the jar would have been very perceptible. If he succeeded at all in satisfying the eye, it is because he did with great deliberation and judgment what might easily be mistaken by the inexperienced for an inconsiderate thing.

It is when such things are undertaken by the novice, without forethought and without discrimination, that they become offensive. Wherever they are inoffensive, be sure they were designed, and designed with more than ordinary skill. It is only a master than can reconcile us to something which, until he did it, we did not think could properly be done. There is nothing careless or casual in the art of design—not even in the little art of ornament.

Miscellaneous.

MALAGASY ARTS.

Many of the Malagasy domestic implements are directly derived from the vegetable kingdom. The Tanalas content themselves with folded leaves of the cardamom plant for spoons and drinking cups. Another section of the community employ the leaves (*fasy*) of the pandanus (*fandrana*), doubled over at one end, as dishes to contain rice or liquid, and folded leaves of the traveller's tree (*Urania speciosa*) for spoons. Many of the Tanalas carry shields made of a circular piece of tough wood, about eighteen inches in diameter, covered with undressed bullock's hide, and with a handle cut out of the solid wood at the back. The women sometimes carry a broad knife or chopper, called *isitra* or *anakantsy*, for cutting up manioc and other roots. The tough bark of *Pavonia platanifolia* would make good string or rope. The whole race is skilful in metal working; with primitive tools they execute fine filagree work in gold and silver, and make very delicate silver chains. Their manipulation of brass, copper, and iron, too, is very creditable. The pottery, made chiefly in the Betsileo country, is, however, poor both in quality and decoration.

BASIC, OR THOMAS-GILCHRIST PROCESS IN 1885-86.

The total make of steel and ingot iron from phosphoric pig, during the twelve months ending 31st October, 1886, amounts to 1,313,631 tons, being an increase for the previous twelve months of about 368,314 tons. Of this make no fewer than 927,284 tons were ingot iron containing under ·17 per cent. of carbon.

The makes of the various countries, for the twelve months ending 30th September, 1885, and 31st October, 1886, respectively, are as follows:—

	1885.		1886.	
	Total tons.	With under 18 per cent. carbon.	Total tons.	With under 17 per cent. carbon.
England	145,707	70,813	258,466	161,908
Germany, Luxemburg and Austria	617,514	424,862	883,859	6 1,523
France	130,582	62,390	122,711	77,141
Belgium and other countries	51,514	42,118	48,595	36,712]
Total tons	945,317	600,183	1,313,631	927,284

These 1,313,631 tons of steel represent about 394,000 tons of slag, containing from 30 per cent. to 35 per cent. of phosphate of lime. Nearly all the basic slag made in Germany is finely ground, and used in place of superphosphates.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 19.—"Cameo Cutting as an Occupation." By J. B. MARSH.

JANUARY 26.—"Photographic Lenses." By J. TRAILL TAYLOR.

FEBRUARY 2.—"Electric Locomotion." By A. RECKENZAUN.

FEBRUARY 9.—"Adulteration of Beer." By A. GORDON SALAMON.

FEBRUARY 18.—"Handicraft Training." By HENRY H. CUNYNGHAME.

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

DATES TO BE HEREAFTER ANNOUNCED.

"Miners' Safety Lamps." By EDWARD H. LIVEING.

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Irish Industries." By REV. CANON BAGOT.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

"Railway Brakes." By WILLIAM P. MARSHALL.

"The Living Organisms of the Air: the Effect of Place and Climate on their prevalence." By DR. PERCY FRANKLAND.

"The Cultivation of Tobacco in England." By E. J. BEALE.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

JANUARY 21.—"The Upper Oxus" By TRELAWNY SAUNDERS.

FEBRUARY 11.—"The Economical Condition o India." By DR. WATT, C.I.E.

MARCH 4.—"Our Trade Routes to the East." By MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B.

MARCH 25.—

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

MAY 27.—

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

JANUARY 25.—"New Zealand Scenery." By KERRY NICHOLS.

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

The dates for the following Papers are not yet fixed:—

"Fiji." By JAMES MASON, C.M.G.

"The West Indies." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

"Australian Wines." By RICHARD BANNISTER.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 1.—Opening Address on "The Present Condition of Applied Art in England, and the Education of the Art Workman." By T. ARMSTRONG, Director of the Art Division, Science and Art Department.

FEBRUARY 22.—

MARCH 15.—"Wrought Ironwork." By J. STARKIE GARDNER, F.G.S.

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

CANTOR LECTURES.

The Second Course will be on the "Diseases of Plants, with special reference to Agriculture and Forestry." By T. L. W. THUDICHUM, M.D. Three Lectures.

January 24, 31; February 7.

The Third Course will be on "Building Materials." By W. Y. DENT, F.C.S., F.I.C. Four Lectures.

February 14, 21, 28; March 7.

The Fourth Course will be on "Testing Materials of Construction, especially Iron and Steel." By Prof. W. C. UNWIN, F.R.S. Three Lectures.

March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Structure of Textile Fibres." By Dr. FREDERICK H. BOWMAN, F.L.S., F.G.S. Five Lectures.

April 25; May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 3...Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Watson Smith, "Explosive Kinetite." 2. Mr. T. B. Mumford, "Grinding Machinery, specially applicable to Phosphates."

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. W. Wright, "The Hittite Empire."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edmund Gosse, "Wordsworth *versus* Pope."

TUESDAY, JAN. 4...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. Dewar, "The Chemistry of Light and Photography." (Lecture IV.)

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m. General Meeting for the Election of Officers.

WEDNESDAY, JAN. 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lecture.) Prof. Reinold, "Soap Bubbles." (Lecture I.)

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. 1. General Meeting for presentation of accounts 2. Mr. C. H. Cooper, "The Treatment of Sewage at Wimbledon."

THURSDAY, JAN. 6...London Institution, Finsbury-circus, E.C., 6 p.m. (Juvenile Lecture.) Dr. C. Meymott Tidy, "Chemical Action." (Lecture I.)

South London Photographic (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Annual Lantern Display.

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. J. Dewar, "The Chemistry of Light and Photography." (Lecture V.)

FRIDAY, JAN. 7...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. E. C. de Segundo, "Experiments in Steam-engine Economy."

Geologists' Association, University College, W.C., 8 p.m. Dr. P. H. Carpenter, "Crinoids and Blastoids."

SATURDAY, JAN. 8...Royal Institution, Albemarle-street, W., 8 p.m. (Juvenile Lecture.) Prof. J. Dewar, "The Chemistry of Light and Photography." (Lecture VI.)

Journal of the Society of Arts.

No. 1,781. Vol. XXXV.

FRIDAY, JANUARY 7, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

H.R.H. the Prince of Wales has summoned a meeting of Lord-Lieutenants of counties, Mayors of cities, and other local authorities, to be held at St. James's-palace, on the morning of the 12th inst., for the purpose of considering the report of the committee appointed to frame a scheme for the Imperial Institute. A public meeting, at which the Lord Mayor will preside, has also been convened at the Mansion-house on the afternoon of the same day.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

THE JOURNAL.

The Secretary will be greatly obliged if the members of the Society will inform him at once of any irregularity which may occur in the delivery of the *Journal.*

Proceedings of the Society.

JUVENILE LECTURES.

The first of the two Juvenile Lectures on "Soap Bubbles" was delivered by Prof. A. W. Reinold, F.R.S., on Wednesday evening, 5th inst. The Lecturer began by remarking that though blowing soap bubbles might be considered a childish amusement, it was very fascinating. The careful study of soap bubbles had already yielded valuable information respecting natural laws, and much was probably to be learnt in the future by a continuation of the study. The colours displayed by a large soap bubble, as it gradually thins, were shown by light from an electric lamp reflected from the surface of the bubble. The order in which they follow each other was made more evident by the causing of a plane soap film to reflect the light upon the screen. Newton's measurements, by which he connected the colour observed with the thickness of the film, were then explained, and the subject was illustrated by further experiments, in which thin films of oxide on a steel plate, the colour indicating the temper of the steel, and of lead oxide (Nobili's rings) were shown. Attention was then drawn to the toughness of a soap bubble. Solid bodies, such as a glass rod or the finger, may be thrust into a bubble without rupturing it, provided they be first moistened with the soap solution. A free soap bubble falls to the ground if it has been blown in the ordinary way. If filled with coal-gas instead of with air, it rises. Air and coal-gas being used in suitable proportions, the soap bubble floats in air, neither rising nor falling. These experiments were shown and explained. The surface which a soap bubble exposes to the air is very large when compared with the mass of the liquid in it. If the properties of the surface of a liquid differ from those of the interior, evidence of the difference would be likely to be afforded by the film of the liquid, and accordingly attention was directed to the surface properties of liquids. The terms *viscous* and *viscosity* were explained by reference to such liquids as treacle, pitch, and spirits of wine. The surface viscosity of a weak solution of saponin in water was shown to differ greatly from its interior viscosity. One experiment by which this was shown consisted in gradually pouring saponin solution into a glass cell, in which a small magnetic needle was pivoted on a point. When the needle lay on the surface of the liquid, the approach of a bar magnet produced no effect upon it, but when, by the addition of more liquid, the needle was entirely immersed, it moved freely on the approach of the magnet. The difference between the surface viscosity of water and saponin solution was exhibited by floating a magnetised sewing needle on the surface of each in succession. On the water the needle moved readily under the influence

of a magnet, while on the saponin it appeared to be rigidly fixed. This peculiar surface property of saponin solution was further illustrated by blowing a bubble of it from a clay pipe. On sucking out air, the bubble was seen to shrink and crumple like a silk purse, whereas if it had been of soap solution, it would contract, but retain its spherical form. Attention was then directed to another property of the surface of a liquid, viz., its *surface tension*. The meaning of the term was explained, and the surface tension was shown to be a real force, tending to make the surface occupy the smallest area compatible with the conditions of its existence. In one of the experiments by which this point was illustrated, a plain film was formed on a metal ring and placed horizontally. A loop of silk fibre, moistened with the solution, was dropped upon the film and there remained, having an irregular contour. The part of the film inside the loop was then ruptured by means of a heated wire, and the loop at once assumed a perfectly circular form. Liquids differ greatly in respect of the magnitude of their surface tensions. The difference was shown in the case of water and alcohol, by causing a drop of alcohol to fall upon a layer of water resting on a glass plate. The water was seen to retract on all sides, leaving the plate dry where the alcohol had dropped. The peculiar rotatory motion of small particles of camphor on the surface of water was also shown, as well as the immediate cessation of the motion when the water was touched with a greasy rod. When a liquid surface, instead of being plain, is curved, the surface tension gives rise to a pressure directed towards the concave side of the surface. The influence of this pressure in causing many well-known phenomena, such as the spherical form of liquid drops when unacted on by external forces, the elevation and depression of liquids in capillary tubes, &c., was illustrated by a variety of experiments.

The second lecture will be delivered on Wednesday evening next, 12th inst.

CANTOR LECTURES.

PRINCIPLES AND PRACTICE OF ORNAMENTAL DESIGN.

By Lewis Foreman Day.

Lecture III.—Delivered December 13, 1886.

The Fitness of Ornamental Form.

Whenever a point of art is the subject of discussion, the difficulty of coming to a clear understanding is increased to an incalculable degree by the totally different meanings attached by speakers to the terms, more or less technical, one cannot avoid using. To begin with definitions would not greatly help us. No sooner should we have commenced to define, than we should find ourselves stumbling against other words equally in need of explanation.

What a flood of light would be let in upon the question of decorative design, could we but agree amongst ourselves as to what is meant by the term "conventional." An English artist understands by conventional treatment such a rendering of natural forms as may be consistent with the decorative character of the work in hand. It implies to him that self-restraint, that intelligent selection, that recognition of the material and its characteristics, that strict regard for the purpose and position of the design, without which ornament does not so much as deserve the name of ornament.

To a Frenchman, on the other hand, it stands for all that is helpless and hopeless in art. Nothing remains to be said of that which he has stigmatised as "convention." In that one word he has expressed his supremest contempt for it.

Do not suppose that I mean to say it is merely a matter of nationality. Of course, not all Englishmen are agreed as to what they mean by the word conventional, nor all Frenchmen probably; but there is in its general interpretation in the two countries, an explanation of the respect, as of the contempt, in which it is held.

The Continental use of the word is perhaps the more exact. The conventional is literally that which has come to be accepted; and, as a matter of experience, we find that little or nothing is ever universally accepted until it is already tolerably stale. The accepted thing becomes, therefore, identified with all that is insufferably tedious in modern art. There seems to be no hope or promise in it; it stands for stagnation.

Yet there is another side to the question. We find in the best work of certain periods, and of certain peoples, certain principles which appear to have been generally obeyed; so universally obeyed, indeed, as to warrant us in calling them *the* principles of decorative art. In endeavouring to explain those principles concerning which we have come to some sort of general understanding or agreement, the party of reform adopted, in an evil hour, the term conventional to express that

kind of treatment which, whatever it might be, was adapted to the purposes of decoration. But it proved less easy to grasp the elusive spirit of design than to take possession of the forms in which it was embodied. And the cut-and-dried character of the examples of design adduced by way of illustration led to the supposition that the conventional was nothing more nor less than the trite, the literal meaning of the word lending itself to the confusion.

One may take it that the artistic verdict on conventionism is mainly according to the artists' interpretation of the word. If by conventional ornament we mean perpetual variations on the same old tunes, tunes long since played out; if we mean adherence to the well-worn types; if we mean affectation, imitation, mimicry, a bigoted belief in the letter of the law as it was in the days that are happily past, no one of any originality or invention of his own—no artist, that is to say—can consistently belong to the party of convention.

If, however, what we understand by the term is the spirit in which the past masters of ornament accepted nature as a never-failing source of inspiration, reverencing her most deeply—aye, and following her most truly—in that they were not content to copy, without further thought, the forms nearest at hand—in that they did not imagine for a moment that what she had made fit for her ends must, without modification, perforce be fittest for their very different purposes—then it seems hard to understand how ornament can properly be anything but conventional. A fitter term might be found for it, no doubt; I prefer myself the very expressive word "apt;" but in discussing the thing we cannot well ignore the word by which it is currently known—and we find the word "conventional" in possession.

One can scarcely conceive of ornament which is not, in a manner, more or less modified by considerations altogether apart from the natural forms on which it may have been founded. Even the human form, which is our highest type, and with which less liberty may be taken than with any other of nature's work—even the human form is not ready-made to the hand of the sculptor; and the works of the great masters to which we accord the title of "monumental" are so in virtue of a something which was not in the model of the sculptor, but in his art. Call this subtle quality what you will—conventional, traditional, monumental, ideal, individual—something there is in all applied art (in all art for that matter, but I am speaking now more especially of decorative and ornamental art); something which is, I will not say contrary to nature for it belongs inherently to human nature, but non-natural in the sense that it is not borrowed directly from natural forms.

The very position and purpose of ornament, the method of its execution, and even its construction, insist upon some treatment of natural forms which, for want of a better word, we call "conventional." First, in reference to the construction of ornament. Its mere repetition (which, in a former lecture, I showed to be inevitable) would of itself render such treatment necessary; and even without the inducement of economy, which compels the use of a machine, we should still resort to repetition, if only because the human brain cannot go on inventing without intermission, but needs the comparative rest of repeating itself, even in hand work. In the artist's repetition of himself (unless, by some unhappy chance, he too happen to be a machine), there will always be a certain degree of variety, which there could not be in mere reproduction. But he cannot afford to dispense with repetition, nor need he wish to dispense with it. It is in itself a decorative element in design; it is a preventive against loose and rambling ornament; it exhibits order, and gives scale. The only question is, where and to what extent we should avail ourselves of it.

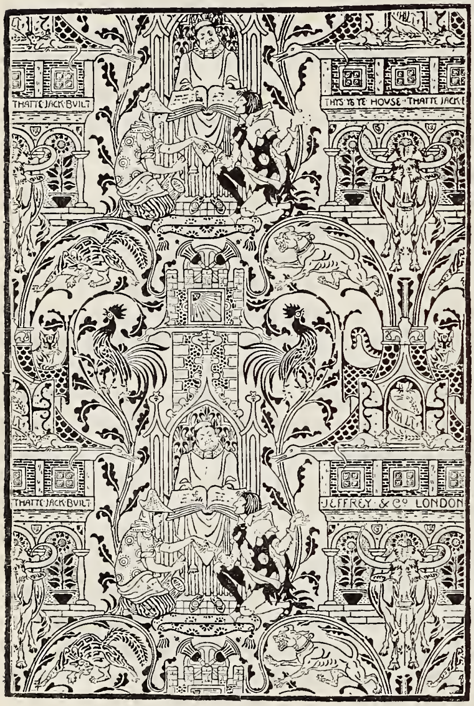
In proportion to the naturalism of a design, and the point of realism to which it is carried, it becomes unsuited to multiplication. To put it the other way about, the oftener it is proposed to repeat a form, the more imperative it is that it should be removed from the imitation of nature, and the further it should be removed. It needs, in short, adaptation to the purpose of repetition, and it is adapted only in proportion to what I may call its reticence. A highly elaborate and attractive feature—anything, certainly, that is in the least self-assertive—will not bear so much as reduplication, whereas any insignificant device may be multiplied *ad infinitum*. In anything of the nature of a background (and so many manufactures are intended to serve only as backgrounds) repetition is of the utmost service; and repetition, as I said, implies modification.

The want of some such modification is very strongly felt in figures which are repeated over and over again. There is an instance of this in a frieze of figures on the wall, which was executed some years ago in wall

paper. Notwithstanding the decorative treatment of the figures, with every repetition their charm would be discounted. There is a similar, and even a stronger, objection to the frieze next in order. Those same little boys in the same little boat would occur with exasperating regularity round the room.

Against the nursery wall-papers, first made popular by Mr. Crane, the latest of which is shown, there is not so much to be said. For

FIG. 16.



such a purpose there is no great harm in degrading, once in a while, the human figure to the office of pattern work. The artist must be allowed to put off his dignity now and again, and indulge in an artistic frisk. Even a bad joke may be occasionally more to the point than an everlasting and deadly seriousness; and this is an exceptionally good one.

The presumable reason for introducing figures into monumental design is for the sake of some added interest or suggestion there may be in them. But you cannot get up any absorbing interest in a series of figures all identically of one pattern. They suggest too much the means employed in producing them. The multiplication of the figure, far from multiplying its interest, diminishes it in exact proportion to the number of times it is repeated. And though it be a very good thing that it is repeated, the case is not greatly mended — it is so easy to have too much of a good thing. The only safety is in toning down the repeated form until its recurrence ceases to be very obvious. This may be effected in various ways. In certain leather paper, and such like designs, it is brought about partly by the low relief of the stamping, partly by the softness of the colouring, and partly by a more or less cunning complication of the cupids (or whatever it may be) with the rest of the design, so that they do not thrust themselves into notice. The consideration which occurs in such a case is whether it was then worth doing. Perhaps not. Except that ornament has a way of being a trifle too ornamental, or, rather, I should say, too monotonously ornamental; and the introduction of any bold mass, such as the figure very readily gives, is one obvious way out of the besetting danger.

Even with regard to birds, beasts, and all such living, and especially moving, creatures, there is a *primâ facie* objection to their repetition. In the case of a wall-paper design such as that shown on the wall, one can scarcely help regretting that it was not executed in tapestry, with a whole pack of hounds in full career, and a family of piping Pans; but that is to regret that wall-paper is a makeshift, which it undoubtedly is. All manufacture is a makeshift for handwork. We ought rather to be satisfied that the makeshift should be as good (unless by any chance, we happen to be workers in tapestry).

The advisability of introducing animal forms into mechanically repeated manufacture depends entirely upon the possibility of keeping them in appropriate subjection—in their place, in fact—which, in turn, depends upon the art of the artist. There is a lesson in the artful way the woodland creatures, with which Mr. Crane has peopled his scroll, are kept down. Everything is subdued to what may be called the tapestry key. The forms which first take the eye are the bold lines of the leafage, among which the live things are more than half hidden. It is only by degrees that one becomes fully conscious of them all. That sort of mystery in a design is always delightful. The perfection of design is reached when, however attractive at first sight, it continues to grow upon you, and the more you contemplate it, the more you see in it.

Observe that the natural forms I have been condoning in decoration, are in all cases de-

coratively treated. Natural as they may be in design, they are yet more ornamental—they are not painted, for example, as Landseer would have painted them. The objection to naturalism, or perhaps I should say literalism, in forms repeated, applies not only to animal but even to floral forms. It exists in a less degree, inasmuch as they are of less prominent interest; but for all that it exists. The charm of the simplest flower is lost when we see, side by side with it, so many copies of it—not varieties, as they would be in nature, but stereotyped repetitions of the same thing.

The artist yields too readily to the temptation to make a beautiful drawing—forgetting that that is not at all the important point in decorative design, but the effect of the thing in execution, and in its place. Nor is he held in check by the public judgment. Few persons have experience enough not to be misled by the prettiness of a drawing, or the effectiveness of a sample, and so one has slight encouragement to resist. Every artist likes, of course, to make a good drawing. But, if he thought twice about it, he would realise that in very self-defence he is bound to consider the repetition of his design, and all else that concerns its use; and, if he is really a designer, he will know how to make capital of the very poverty of the conditions to which he submits. Submit he must—better do it, then, with a good grace.

Some adaptation of natural forms, some simplification in fact, is demanded not only to fit them for repetition, but, further, by the position and purpose of the work; sometimes in order that the detail may not assert itself too much, sometimes in order to give it the emphasis that is necessary.

For example, an infinity of delicate and laborious work is many a time misspent upon details of domestic furniture, which not only pass unnoticed, but which ought not to attract notice. It often seems as if the workman had set himself to show how far it was possible to go in the direction of minuteness of detail. He may show that, and at the same time illustrate the futility of going anything like so far.

In proposing to carry execution to a point beyond what has hitherto been attempted, it is as well to ask oneself, whether there may not be good reason why the attempt has never been made. Our forerunners were not all of them fools, we may be sure. As a *tour de force*, once and again, anything may be admissible; but a good workman rarely indulges of his own accord in that kind of "brag" (there is no better word for it), which exhibitions, international and other, have done so much to encourage. He is loth to waste labour, and he knows how to make his work tell without shouting at you; often he simplifies, with a view to making his work tell enough in its place. In wall decoration, for example, to be seen from some distance, a merely natural representation of the forms employed would go for very little. By the omission of multitudinous detail, he manages to emphasize what he is anxious to preserve; he even exaggerates the more important features in his design, which otherwise would lose all character at the distance from which they were meant to be seen.

Over and above the omission of irrelevant detail, and the exaggeration of characteristic forms, he modifies their natural colour, and may be enforces his design by the very conventional means of an outline.

A word or two as to outline. It is often of such use in ornament, and so often useful, that it has come to be accepted by certain theorists as a necessity of the case; to them it is the passport of "the decorative." But useful as an outline is in decoration, it is not inevitable, nor is it so easy to say just where an outline should be used. Art is not by any means to be learnt from aphorisms, and if recipes were of any use at all, it would be mainly to those who were not much in need of them.

In very many cases, the material and its workmanlike employment necessitate an outline, and even determine its colour, as in the case of the yellow metal which marks the cells in which the paste of enamel is laid; or fix its thickness as in the lead work, by means of which a stained glass window is held together. In all such cases it is only reasonable to follow the lead given us. It does not do to play altogether from your own hand; the material is, so to speak, our partner in the game of decoration.

It is seldom, however, that an artist will resort of his own free will to an even and rigid outline all round every form. Excepting at a great distance from the eye (where its mechanical equality is not seen), that is almost certain to result in hardness—a defect which, I am sorry to say, is very commonly looked upon as a merit of execution. Mechanical precision is too often the manufacturer's ideal of finish. It is one, unfortunately, which he can all too easily realise—at a loss of what

beauty of feeling and colour he can probably never be brought to know.

The instinct of art is rather to lose an outline, more or less, in places, and only to insist upon it where its value is sufficient to justify the risk its use entails. The only rule which can be laid down as to the use of outline is so extremely simple as not altogether to satisfy the *doctrinaire*. If the need of an outline is urgent, then adopt it; but if no such want is felt, if the effect is satisfactory without it, why on earth should one insist upon its use? For a reason—yes; but not otherwise, surely. The insistance upon outline for the sake of outline, as though decoration were not decoration without this official stamp of pedantry, this trade mark of the decorating shop, is pure nonsense.

The truth is, outline is frequently just a matter of trade expediency, and no more. And a very wise and fit expedient it is, if only in view of that process of reproduction which, as I have said, is one of the necessities of modern decoration, and particularly of modern ornament. The vaguer forms which depend so much upon the touch and feeling of the artist do not lend themselves to this necessity. Now, an outline does. And if, in outlining his drawing, the designer cannot help in some degree hardening it, the evil is infinitely less than if the more undefined and delicate forms had been left to the tender mercies of another. Possibly he may find his reward in the executed work, in which, if he has been at all equal to the emergencies of the case, he will find again a delicacy equivalent to that of his original drawing.

Even in autograph work, where the artist executes his own design, he still avails himself of outline. Decorative art is a kind of shorthand. Its very existence seems to depend upon its being done with readiness, quickness, and certainty—so that he who runs may read. That which asks for careful scrutiny to be appreciated will, for the most part, fail to win appreciation; it may have all manner of merits, but if it hides them, it has no right to complain that men pass it by. Poetry itself that is over subtle, is not popular; and decorative art is essentially popular art.

The effectiveness so much to be desired in decorative art, has to be obtained without many of the resources of which the painter is free to avail himself. It is not often that we can indulge in extremes of light and shade, nor yet in very strong modelling; and under these circumstances, an outline is invaluable in helping to detach figure or ornament from its background. It is wonderful to see how effectually even a delicate outline will sometimes do this.

In work placed at a great distance from the eye, outline is, if not actually necessary, at least the simplest and most available means of definition. The greater the distance off, and the less the contrast in tone and colour between the design and its background, the more urgent something of the kind becomes. For all that, there is no law making an outline compulsory, unless the artist feels the need of it. He may, if he please, detach his pattern from the ground by deepening the one, or lightening the other, or by doing both; but that would ordinarily be a much more laborious business. Besides, it is only fair to assume that there was some reason for the choice of tones adopted in the first instance, and it may be anything but desirable to modify them. Thus it happens that in so many instances the expedient of an outline is preferable. It enables one deliberately and safely to adopt a scheme of colour which, but for it, would be altogether ineffective.

I am not assisting upon the use of outline, but showing of what use it may be. Don't, by any means, accept the dogma of its saving merit, and don't let it tyrannise over you. Art may quite well be decorative in which the outline is not emphasised; nor does the insistence upon it make design decorative, however effectually it may remove it from the pictorial.

It is time I came back to the reasons for conventional treatment in design. The most urgent of them remain yet to be considered, viz., the nature of the material, the character of the tools, and the process of execution employed.

In discussing the anatomy of pattern, I pointed out how its construction was affected by, and very often directly due to, some particular manufacture or method of work. So it is with the details of ornamental design. The exquisite simplicity of certain characteristic patterns familiar in the figured velvets of the 15th century is cleverly calculated to disturb the least possible amount of the sumptuous pile, so that the full value of the rich texture is preserved. Again, in the Renaissance damask patterns, those big leaves and scrolls are devised with a view, before all things, of getting a broken effect of colour. The designer relied upon the quality of the silk, with its varying sheen, to alleviate the exceeding flatness of the pattern. In a multitude of smaller parts,

the admirable repose and breadth of the design would have been lost, as well as something of the quality of the stuff. Our manufacturers desire equally to exhibit the quality of their material, but they can think of no other way of doing it than by leaving it empty. Perhaps they have the lady purchaser in view; anyway, they appear to have a rooted belief in the suitability, or saleability of the *petite*.

By the way, it should be pointed out that in certain other woven fabrics of our time the hope of disguising the shabbiness of the material has led to adoption of the fussiest kinds of patterns. One should beware of textiles worried all over with pattern—in many cases it is done to hide shoddy. The manufacturer of *boná fide* silk, or wool, or other worthy material, would do well to identify his goods with a kind of design which the baser fabrics cannot imitate without convicting themselves.

The character of the Lyons silk designs of the 17th and 18th centuries owes very much, I take it, to the circumstance that the lustrous material was so fascinating, that the artists were led astray from beautiful form, and simply revelled in the delights of colour. Charming as these silks often are, translate any one of the patterns into uncompromising black and white, and you are disillusionised at once.

In these later figured silks, as well as in the earlier damasks, the pattern was usually designed without much regard to the joining of the breadths. The designer doubtless reckoned that the material would be used for curtains, to fall in full folds; for furniture, in which a single breadth only would be used; or as a dress fabric, in which the pattern would never by any chance be seen in its entirety at all. To this day silks and velvets are designed in France so that the pattern groups itself into two unequal bouquets, the one intended for the back of a chair, the other for the seat.

The style peculiar to each particular kind of work is, indeed, so strongly marked, that it would be quite feasible to classify ornament according to its evolution. "Style," said Mr. Wornum, "is analogous to hand in writing;" and not a tool or process but has written its character upon the work it has done. It was so even in so simple a matter as lettering. The cuneiform character of the ancient Assyrian inscriptions was developed chisel in hand, as you may see in Fig. 17. In the same diagram you will perceive how Chinese or Japanese writing could only have been shaped by the brush; and again in the example of very early Greek character, the influence of the stylus seems to betray itself.

Fig. 17.

The simple forms of the Roman letters A B C, &c., in Fig. 18 (p. 124), might equally have been indented on a soft substance with a point. The later form of lettering, shown in D E F, with its thick and thin lines and its spurred ends, was better calculated for incising or engraving. Or it might have been due to the use of the pen, as the Gothic form of the letter, exemplified in G, undoubtedly was. Again, the smaller Roman letters h, i, j, are unmistakeably related to the "round hand" k, l, m. But it is in the mediæval "black letter" that the penmanship is most plainly pronounced, as in the letters n, o, p, r, s, t, or in the capital 𝔄, or the yet more fantastically flourishing 𝔚.

In our own day we are given to the cultivation of "a good business hand," which is just a little characterless and monotonous, as are indeed the lives of some of those who accomplish that modest end. Time was when the pen of the ready writer indulged in occasional

flourishes. There is no time for such frivolity nowadays; and what little character there is left in our hand is likely to be sacrificed to the convenience of the stylographic pen, even if we do not give up penmanship altogether in favour of what is called "the literary machine."

Style, then, as I understand it, is not so much a thing of dates and countries as of materials and tools. Whenever the development of ornament is discussed, it is the custom to begin with the savage. How the

FIG. 18.

aboriginal developed into the Assyrian is not very clearly shown. But from Assyrian art is traced Egyptian art, and from that again Greek art, and its Roman imitation—all very plausibly. The foundations of Byzantine art upon the ruins of classic, the growth of Gothic, the reaction of the Renaissance, its transplanting, and its degradation, follow in accustomed order. It is easier to jog along this well-beaten and rather tedious road than to explain how, all the while parallel with this Oriental art was pursuing a course of its own, impinging, nevertheless, at times upon Western art, and whenever that was the case, leaving the imprint of its influence upon it. This would be well worth doing; but it would take a long series of lectures to do it in, and would demand, besides, historical knowledge far greater than I can pretend to—a knowledge perhaps scarcely compatible with the necessary knowledge of art.

Still more to the purpose would it be to classify ornament according as it was plaited, notched, scratched, turned, modelled, carved, painted, inlaid, printed, woven, embroidered, or what not. Architecture would divide itself into masonry, brick, concrete, timber, and plaster styles; the subsidiary arts would class themselves according to the use of clay, stone, wood, metal, yarn, and so on, in them; and there would be further subdivisions into granite, marble, sandstone; into hard and soft wood, close grained and variegated; into wrought, cast, chased or beaten metal; into tapestry, cloth, damask, velvet, brocade, embroidery, lace, and so on.

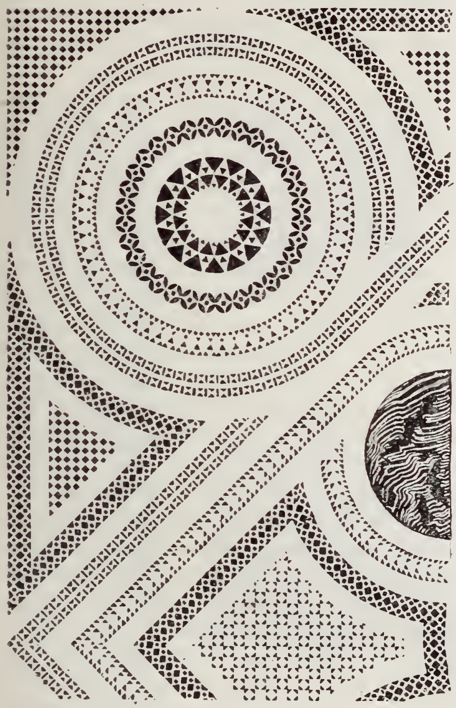
What are known as the historic styles might be examined by the way; they would go to illustrate the development of style more technically considered. In all probability it would be shown that wherever the historic style is marked, its character is to be traced to some mode of workmanship which, if it did not actually inspire it, made it advisable. The characteristic ornamental forms of a period or people can usually be traced to the technique and needs of that same people. Thus far, ornament rises to the dignity of history.

Such a classification as I have sketched would lead us very far afield; it is possible, however, to give shortly some illustrations of what is meant. Compare for a moment the sculpture of Egypt, of Greece, and of mediæval Europe. The styles are not more distinctly Egyptian, Greek, and Gothic, than they are markedly granite, marble, and soft stone styles. The monumental simplicity of the obelisk, the refinement of the Pheidian temple, the rude grandeur of the Gothic minster, were but the natural development of the resources near at hand.

Working in porphyry, basalt, or granite, severe simplicity was inevitable, and the Egyptian was severe with a vengeance. There was no temptation to him to fritter away all breadth in the accumulation of detail. On the other hand, the more even-textured and less obstinate marble encouraged the Greek sculptor to greater and ever greater delicacy and subtlety of execution, which, again, would have been altogether out of the question in carving the more friable stone employed

in our own country. In like manner the richer scheme of architectural colouring which prevailed in Italy was encouraged, if not altogether suggested, by the gorgeousness of the multicoloured marbles within easy reach; which marble led also to the development of a kind of decoration, very characteristically mosaic, in which the beauty of the material is displayed in large slabs of rich veneer, whilst the waste is used up in the form of geometric pattern work, the design of which is literally cut according to the chips. Fig. 19 shows

FIG. 19.



somewhat the kind of thing alluded to; but it gives only imperfectly a very common feature in the Italian pavement patterns, which is a big circular plaque of porphyry, or what not, recurring at intervals in the design. This was in all probability only a device for turning to account the odd columns remaining from ancient buildings. The plaques are, in fact, so many slices of old columns; but what admirably ornamental use has been made of them!

The adoption of geometric patterns for inlaid pavements was countenanced by the circumstance that the unequal and accidental colour of the marble cubes just counteracted the tendency to mechanical hardness, in which lies the danger of purely geometric ornament.

So in the ornamental glass mosaic so often used in Italy in Giotto's time in connection with white marble, the shimmer of the surface, more especially as it was never absolutely even, put all contingency of harshness out of the question. Such a thing was not possible with all these little facets of glass catching the light at all manner of angles, and glittering each according to its own bright will.

In wood inlay, or marquetry, similar geometric forms were found, for similar reasons, to be eminently serviceable, so that one may say that, whether in wood, or glass, or marble, a style of inlaid pattern work was begotten of the very facility of shaping and laying geometric forms by the certainty of the harmonising influence of colour.

It is in the inlay of natural woods and stones and the like that we find the most satisfactory use of absolutely geometric pattern. The accidental variation of the natural colours is exactly the thing needful. The unexpectedness of the tints makes amends for the certainty of the shapes, and gives an air of mystery to what would otherwise be only so much mechanism.

The conventional treatment of foliated forms (of which I shall have more to say in my next lecture), in all countries and in all times, until a comparatively recent date, has borne the impress of its execution. The so-called honeysuckle of the Greeks I have shown elsewhere* to be directly traceable to the use of the brush, as was the case with other familiar forms of painted Greek ornament. The Corinthian capital, on the other hand, and the acanthus scroll, even when they most nearly approach nature (which is never very closely) are always modified according to the conditions of sculpture.

In the Byzantine version of the classic leafage, in which the sculptors made abundant use of the drill, the drill holes form an element in the design. The characteristic turn about it is the turn of the drill.

The somewhat savage enrichment of our own Norman buildings reminds one forcibly of the rude way in which it was done. It is chopped rather than carved. And in the Gothic rendering of foliated forms, whether carved in stone or wood, or painted on wall or window, or wrought in metal, there is always a touch of the tool which removes it by so much, I will not say

* "Everyday Art," p. 106.

from nature, because the instinct which directs all such modification is natural enough, but from the imitation of nature.

To refer to a specific material, you cannot look at the ironwork of any early period without seeing how directly the forge has influenced its design. The Italian scroll is more graceful than the English, the German more fantastic and elaborate. The work of Augsburg is not even just that of Nuremberg. But with all its variety it is everywhere characteristic of the smith. Even when it breaks out, as it did in the 17th century, when art knew no restraint, into an uncomfortably bristling form of foliage, it breathes always the atmosphere of the forge. Nature inspired, the hammer and the pincers shaped it.

It is precisely for this reason that our modern casting of wrought forms is so singularly ill-judged. There is nothing contemptible in cast iron if we would but abstain from the reproduction in it of forms altogether inappropriate to casting. We should have no cause to regret that the day of the foundry has come, if founders would but put some real art into their moulds; and the first step towards that end would be to forget, if they can, the familiar forms of the forge. People talk about cast iron as if it were an abomination; and so it often is; but there is no reason but our incompetence why we should not do in iron in the 19th century what the Italians did in bronze in the 15th.

It is not to be supposed that any one but a workman will ordinarily know enough of technique fully to appreciate the influence of tool and treatment upon ornamental design, still less to trace the origin of ornamental forms to their first cause; but it is none the less true that most, if not all, ornament may be followed back to such a source.

Take any tool in hand and proceed to design with it, and see what comes of the experiment. It will be something quite different from what you would have drawn with a pencil on paper, and something much less literally like anything natural.

You know how embossing or *repoussé* work is done. You take a sheet of thinnish metal, say copper, and lay it with its polished surface downwards on a bed or cushion of pitch, and proceed with tools of various shapes and sizes to punch up the pattern from the back. Now, if you have any feeling for the material at all (and if you have not, you have mistaken your vocation), you begin very naturally to do what *can* be done in it. Accordingly you set to work to beat out certain round bosses, which you surround with smaller bosses, arriving so at something like flowers. These you go on to connect with rounded stems, from which grows a kind of foliage, large or small in detail as need may be, but always more or less bulbous in shape. You arrive thus at a pattern which is characteristically *repoussé*, beaten work, and which has grown to a great extent out of the conditions under which you were working. And it cannot be insisted upon too strongly that in designing for ornament, it is absolutely essential always to have those conditions in mind, as clearly as though you were yourself working under them.

In beaten work you descend from the mass to the minutiæ; in filagree, on the contrary, you would work from the minutiæ to the mass. Commencing with wiry lines, you would perhaps clothe them with more compact spirals, clustering these together where you wished to concentrate the effect. This is the type of all ornament in delicately elaborate line, as, for instance, niello or damascening, or embroidery in gold or silken outline, or, on a larger scale, hammered ironwork. Substituting straight lines for curved, it has its parallel in certain kinds of lacework, and in some of the bookbinders' "tooling" of the 16th century, which is indeed founded upon lace, but which has, nevertheless, a character of its own.

To take a last homely instance. Suppose you were designing for fret work. The very idea of fret-cutting would suggest a kind of pattern familiar enough. Either you would devise a form of pierced ornament, having all the character of stencilled work (the stencil is, in point of fact, a paper fret, through which you dab on the paint), or, if you preferred to cut away the ground instead of the pattern, you would be bound to hold the design together by ties. These would sadly mar the effect of your pattern, unless from the first you took them into consideration, which you would instinctively do; and the result of it would probably be some sort of strapwork, such as that which is so infallible a feature in Elizabethan wood-carving, which very possibly owed its origin in part to some such device, though its more evident source is in the forms peculiar to metal work.

The stencil patterns in Fig. 20 (p. 127), explain themselves pretty well. They are designed to be stencilled right off, without any need of making good afterwards.

In the case of the radiating pattern the ties

themselves are made use of to form a pattern on the pattern; so many conventional veins to equally conventional leaves.

The characterlessness of 19th century ornament is due very largely to the absence of any impress of the tool upon design. In the process of modern manufacture, everything is planed down to a marvellous but monotonous smoothness; the mark of the tool, which is the evidence of workmanlikeness, is popularly regarded even as bad work—want of finish, indeed. There are some, in this enlightened age of ours, who need to be reminded that the smoothly smug is not the beautiful, nor even the finished. Not that the fallacy is altogether

FIG. 20.

a modern one. Tapestry designers for centuries past have been working steadily in the pictorial direction, and against the threads, until there is now little difference between the picture and its copy in wool, except that the latter costs ever so much more than the original. Even in the comparatively early tapestries of Raffaelle you can see at Dresden or Beauvais what inferior and characterless hangings his famous cartoons make, as compared with the designs of earlier, unknown, and less accomplished draughtsmen, who knew their trade. Raffaelle either knew little or cared little about tapestry, that is clear, and in his failure there is some consolation for the least of us. If we only love our trade and know it, as only those can who love it, we may succeed where a Raffaelle would fail, though we may be anything but Raffaelles.

The crowning point of inconsistency is achieved where it is not nature that is copied, but some convention peculiar to, and characteristic of, a quite different material or treatment—as when the bulbous character of beaten metal, or the facets of monstrous jewels, are imitated in wood-carving, or when the broken lines which occur inevitably in coarse carpet-weaving or Berlin wool-work are copied in wall-paper.

Equally absurd is the application to any purpose of a process altogether out of keeping with it. I remember seeing in Paris some years ago (1882) a chimney piece built on the massive lines of the François premier period, but executed in wood instead of stone, and completely covered, mouldings and all, in cloth, embroidered in the place of sculpture, and fitting as faultlessly as though a first-class tailor had done it. And only the other day I noticed, in a London shop window, an easel covered in crimson plush, draped with a scarf of the same, presumably as an ornament for the drawing-room. It is only natural to try and turn one's trade to the utmost possible use, partly out of workman-like pride, and partly out of considerations less conspicuously praiseworthy; but this kind of thing is a *reductio ad absurdum*, which in the end must discredit a calling. There is never an exhibition but we are warned by ill-judged exhibits, over and over again, against the theory that there's "nothing like leather." Why can't we be content to do what we can do, and do best?

Assuming, on the one hand, the urgency for some modification of natural forms according to the work in hand, and on the other, of some continual reference to nature in design, the question arises as to the limits of the one and of the other. How far may one safely go in the direction of nature? And to what extent is it well to admit the dictation of the tool? In order to settle that point quite definitely, each separate craft would have to be discussed. An excellent prescription would be just so much of natural food as the artistic stomach can digest; but then we have to reckon on a person's powers of artistic assimilation—always an unknown quantity.

The conclusion I have arrived at is this, that the convenient stopping point is the point at which a material or process fails; the point,

in fact, at which one is tempted to bring in some supplementary process; which process, under pretence of helping it, ends eventually, more or or less, in effacing it. I don't mean to say that two or more processes may not be associated, but there should be very good reason shown for their association.

In all applied art, and in every stage of it, the work in hand points out, if you will only listen to it, the degree and kind of conventionality that is called for. I lay down no law but this: consider the nature of the materials and tools you are using, and the place and purpose of your work. So much convention as they suggest is needed, and no more.

Miscellaneous.

RICE CULTIVATION IN HAWAII.

Consul Putnam, of Honolulu, says that the rice product in Hawaii is only second in importance to sugar. The fields are called patches, most of them having been formerly used by the natives in raising their favourite food, *taro*, and are often not more than an acre in extent. When new lands are occupied, banks of earth are thrown about the margin of the patches, and the soil is thoroughly worked; water is then run in, and allowed to remain until the ground is thoroughly saturated. The paddy is then sown like oats, sinking in the soft soil. It is allowed to grow until it is about six inches in height, when it is transplanted in other patches, in rows about six inches apart. The plants are then continually flooded with water for about five months, or until the grain has formed and begun to harden. The water is then drawn off, and the paddy allowed to ripen; it is then cut with sickles, dried, and threshed, the old system of threshing upon a floor, with horses, being in vogue. It is then winnowed, placed in sacks, and sent to the mill for hulling and polishing, the same process and machinery being used that are employed in the rice mills of Louisiana. The rice being ready for market, is packed in bags, each containing 100 pounds, and is ready for export. The climate is peculiarly adapted to the cultivation of rice of a superior quality, and in unequalled quantity, its evenness of temperature permitting the raising of two crops per year without any particular strain upon the soil. The fields are confined to the lowlands, where abundant irrigation can be obtained, and to the slight elevations when artesian wells can be successfully established. They are the highest priced lands in the kingdom, if a price can be fixed upon them, as none have been in the market for many years. Nominally, they range from £20 to £40 per acre, owing to facilities for irrigation and also of communication. They are leased on contract from five to twenty years, on rentals varyimg from £3 to £6 per acre. The total area of land suitable for the productiou of rice is about 4,700 acres, and the local consumption is about 100,000 bags. The quantity exported in 1884 amounted to 2,493,000 lbs. of rice, and 46,662 lbs. of paddy. The rice culture in Hawaii is almost exclusively in the hands of the Chinese, both employers and *employés* being alike Celestials. The ordinary labourer is employed under the general contract system for a given period, but the Government has not been called upon to extend a special protectorate, as in the case of other nationalities. The contract price for labour is about £3 per month and board, or a little over £4 without board. The *lunas* or overseers receive from £2 to £3 per month more. They can receive their wages as earned, or in a lump sum at the harvesting of the crop. The hours of labour are ten to twelve each day, and when found, the labourers are supplied with what they require of rice, meat, fish, bread, tea, coffee, or such other provisions as they desire. Spirits are supplied during the period their work requires them to be constantly in the water. It is estimated that the total number of labourers employed in the cultivation of rice in the islands is 1,500.

Correspondence.

CULTIVATION OF THE SO-CALLED WILD SILKS OF INDIA.

I have read with great interest Mr. S. Cunliffe Lister's letter on the subject of sericulture in India, and I cannot help thinking that he has not had the opportunity of seeing tussur silk cultivation in those parts of India where it has been carried on for many centuries, and that he has not fully realised its future possibilities, otherwise he would not have stated that "it must be limited beyond all question to what the jungle can produce at little cost."

Now what are the facts; first of all, there is no doubt that the jungle consists in many parts of the country of the plants on which the tussur worm feeds, and we, therefore, start with a very large tract of country naturally planted with the trees in which tussur silk can be reared, and that, instead of having to plant out acres of mulberry trees, we have existing many thousand square miles of sal and assum, and other trees which form the food of the tussur silkworm. The next point is where are the people to look after the cultivation of tussur on this vast area of suitable jungle; to which I reply that nearly all the aboriginal tribes inhabiting India will be found to be available for this purpose. At present the cultiva-

tion is extremely limited to a few families, or to a few tribes who have been accustomed to the work from time immemorial, but their numbers can and are being recruited in great numbers, and in the course of a few years the number of men engaged in this cultivation will be increased an hundredfold.

The present competition among European firms in purchasing tussur has already increased the price enormously, and the result will be increased production, for, as I have already pointed out, the trees are already planted out and at hand, and if the people find it pays them, there is nothing to prevent their increasing their cultivation. The only point which retards immediate increase is the difficulty of procuring seed cocoons, for, in most cases, they have to be sought for in the wild state in the jungles; but although this is a difficulty, it is evident that cultivation over a large area will afford more seed cocoons the next crop, for in every cultivated track there are always a few cocoons which escape detection and collection, and which add to the number of wild cocoons found in the next brood; besides, it is not necessary, although desirable, that the seed cocoons should have been wild.

I do not know what Mr. Lister refers to when he says, "it is quite a folly to suppose that tussur or any other wild silk can be reared to pay, because in all cases it will cost as much and in many (more particularly tussur) vastly more than mulberry," for certainly it does not cost the people who rear tussur as much to rear a maund of tussur silk as it would do to rear the same quantity of mulberry silk. In the one case of tussur, the whole cost consists of the labour of the cultivator, the cost of the seed cocoons, and the rent of the jungle, which is generally rated at four annas or 6d. per man, and he may take up as many trees as he likes; this refers to sal forests; assum or *Terminalia tomentosa* trees are a little dearer in some parts, and will soon also rise in value.

It is a very precarious cultivation, and the results may be great gain or total loss as the season is favourable or unfavourable, but the profits are so great in a favourable year that the cultivator can afford to lose one season. There are several crops in the season, and if one fails the others may succeed. I have cultivated tussur for three years, and yet I am not prepared to say how many broods are possible in one year; one brood so overlaps the succeeding one, that it is very difficult to determine the one brood from the other.

It is also a very difficult matter to decide which is the tree which the wild tussur prefers. I am inclined to think that the sal (*Shorea robusta*) is the tree, although the best cocoons are obtained from the *Terminalia*. One interesting fact in connection with the food of the tussur worm is, that it can be fed and reared on rose bushes, a fact which I discovered while trying to find out a tree that was common to all climates in which tussur could be cultivated.

What I would therefore urge is, that although it might not pay the Bengali to rear tussur, there are thousands of aboriginal inhabitants of India whom it does pay, and who could never earn a meal by cultivating mulberry silk; and that if the demand continues at its present figure, the supply will be in proportion, for as I have attempted to point out, there is nothing to prevent an immediate increase of production to an almost unlimited extent.

T. F. PEPPE.

Camp, Nov. 23rd, 1886.

General Notes.

AUSTRALASIAN ASSOCIATION.—At a meeting of intercolonial delegates, held on November 10 last, at Sydney, it was resolved to form an Australasian Association for the Advancement of Science. The first election of officers is to be held in Sydney in March, 1888, and the first meeting of the Association in the first week of the following September.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 19.—"Cameo Cutting as an Occupation." By J. B. MARSH. FRANCIS COBB, Treasurer of the Society, will preside.

JANUARY 26.—"Photographic Lenses." By J. TRAILL TAYLOR.

FEBRUARY 2.—"Electric Locomotion." By A. RECKENZAUN.

FEBRUARY 9.—"Adulteration of Beer." By A. GORDON SALAMON.

FEBRUARY 16.—"Uses, Objects, and Methods of Technical Education in Elementary Schools." By HENRY H. CUNYNGHAME.

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

DATES TO BE HEREAFTER ANNOUNCED.

"Miners' Safety Lamps." By EDWARD H. LIVEING

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Irish Industries." By REV. CANON BAGOT.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

"Railway Brakes." By WILLIAM P. MARSHALL.

"The Living Organisms of the Air: the Effect of Place and Climate on their prevalence." By DR. PERCY FRANKLAND.

"The Cultivation of Tobacco in England." By E. J. BEALE.

Indian Section.

Friday evenings, at Eight o'clock:—

January 21.—"The Upper Oxus" By Trelawney Saunders. Malcolm Low, M.P., will preside.

February 11.—"The Economical Condition of India." By Dr. Watt, C.I.E.

March 4.—"Our Trade Routes to the East." By Major-General Sir F. J. Goldsmid, K.C.S.I., C.B.

March 25.—

April 29.—"Village Communities in India." By J. F. Hewitt.

May 27.—

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

January 25.—"New Zealand Scenery." By Kerry Nichols.

April 19.—"South Africa." By Major-General Sir Charles Warren, G.C.M.G.

The dates for the following Papers are not yet fixed:—

"Fiji." By James Mason, C.M.G.

"The West Indies." By Sir Augustus Adderley, K.C.M.G.

"Australian Wines." By Richard Bannister.

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

February 1.—Opening Address on "The Present Condition of Applied Art in England, and the Education of the Art Workman." By T. Armstrong, Director of the Art Division, Science and Art Department.

February 22.—"Wrought Ironwork." By J. Starkie Gardner, F.G.S.

March 15.—"The Application of Gems to the Art of the Goldsmith." By Alfred Phillips.

April 26.—"Ornamental Glass." By J. Hungerford Pollen.

May 10.—

May 24.—"The Importance of the Applied Arts and their Relation to Common Life." By Walter Crane.

These dates are liable to alteration.

Cantor Lectures.

The Second Course will be on the "Diseases of Plants, with special reference to Agriculture and Forestry." By T. L. W. Thudichum, M.D. Three Lectures.

January 24, 31; February 7.

The Third Course will be on "Building Materials." By W. Y. Dent, F.C.S., F.I.C. Four Lectures.

February 14, 21, 28; March 7.

The Fourth Course will be on "Testing Materials of Construction, especially Iron and Steel." By Prof. W. C. Unwin, F.R.S. Three Lectures.

March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Structure of Textile Fibres." By Dr. Frederick H. Bowman, F.L.S., F.G.S. Five Lectures.

April 25; May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 10...Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Mr. S. J. Mackie, "The Origin and Objects of the Inventors' Institute."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Captain V. L. Cameron, "Urua: its People, Government, and Religion."

Tuesday, Jan. 11...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Professor Alex. B. W. Kennedy's paper, "The Use and Equipment of Engineering Laboratories."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8 p.m. Mr. George Watt, "A Brief Account of the Aboriginal Races of Manipur and the Naga Hills."

Biblical Archæology, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Colonial Institute, Prince's-hall, Piccadilly, W., 8 p.m. Rev. James Chalmers, "New Guinea—Past, Present, and Future."

Wednesday, Jan. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lecture.) Prof. Reinold, "Soap Bubbles." (Lecture II.)

Geological, Burlington-house, 8 p.m. 1. Mr. J. S. Gardner, "The Ardtun Leaf-bed," with Notes by Mr. Grenville A. J. Cole. 2. Professor P. Martin Duncan, "The Echinoidea of the Cretaceous Strata of the Lower Narbadá Region." 3. Mr. R. Lydekker, "Some Dinosaurian Vertebræ from the Cretaceous of India and the Isle of Wight." 4. Mr. W. Whitaker, "Further Notes on the Results of some Deep Borings in Kent."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. 1. Mr. A. W. Bennett, "Fresh Water Algæ (including *Chlorophylloceous protophyta*) of North Cornwall; with descriptions of six new species." 2. Mr. J. Mayall, jun., "A Visit to Jena."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi W.C., 3 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

Thursday, Jan. 13...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. (Juvenile Lecture.) Dr. C. Meymott Tidy, "Chemical Action." (Lecture II.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, Jan. 14...Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.

New Shakespeare, University College, W.C., 8 p.m. Mr. R. G. Moulton, "The Tempest: more Particularly as a Study of Poetic Justice."

Journal of the Society of Arts.

No. 1,782. Vol. XXXV.

FRIDAY, JANUARY 14, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

The following letter from H.R.H. the Prince of Wales, President of the Society, was read at the last meeting of the Council.

Sandringham, Norfolk,
8th January, 1887.

Sir,—The Council of the Society of Arts are aware of the interest which I am taking in promoting the establishment of an Imperial Institute for the United Kingdom, the Colonies, and India, and they are likewise acquainted with the scheme which has been prepared by the Committee which I nominated for the purpose.

As President of the Society I wish to invite the aid of the Council in perfecting and carrying out the admirable scheme of the Committee.

I shall also be gratified to learn that the Society will use the influence it possesses throughout the kingdom in assisting to collect the funds which will be required to ensure the complete success of the object I have in view.

I am, Sir,
Your obedient servant,
(Signed) Albert Edward P.

The Chairman of the Council
of the Society of Arts.

It was resolved :—

1. That the Chairman be requested to acknowledge the letter received from H.R.H. the Prince of Wales, and to assure his Royal Highness of the cordial co-operation of the Council in the scheme for the formation of the Imperial Institute as now approved by his Royal Highness.
2. That the Council resolve itself into a committee to consider the best means of carrying out his Royal Highness's wishes.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Two Gold Medals and Four Silver Medals for prime movers suitable for electric-light installations.

The medals will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class.

(A.) Motors in which the working agent is also produced (steam and gas engines).

(B.) Motors in which the working agent must be supplied (steam, gas, and hydraulic engines).

Each class will be subdivided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p.

The entrance fee will be £2 10s. per h.p., to be paid on entry.

The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

The full statement of the conditions under which the medals are offered can be obtained on application to the Secretary, and will be found in the number of the *Journal* for December 17.

Proceedings of the Society.

JUVENILE LECTURES.

On Wednesday evening (12th inst.) Prof. A. W. Reinold, F.R.S., delivered his second and concluding Lecture on "Soap Bubbles." After briefly referring to the experiments shown in the previous lecture in illustration of the action of the surface tension of a liquid, the Lecturer proceeded to give further illustrations. Thus it was shown that a piece of wood or cork, or any light substance floating on the surface of water, is attracted to the side of the containing vessel, or to any similar piece of floating substance, provided both are wetted by the liquid. Attraction similarly occurs between two floating bodies, neither of which is wetted by the liquid. Thus, if a sewing needle is slightly greased and dropped upon the surface of water it is not wetted, and is supported by the pressure due to the depression

it causes in the surface. If another similar needle be dropped by its side, the two at once move together. The needle, however, is repelled from the side of the containing vessel, or from any substance which is wetted by the liquid. These experiments were shown and explained. The term *curvature* was explained, and it was shown that the pressure exerted by a soap bubble upon the enclosed air depends upon its curvature, being greater as the curvature was greater—that is, as the bubble is smaller. A glass tube from which a bubble could be blown was connected with a very sensitive water-pressure gauge. The air was then gradually withdrawn from a spherical bubble which had been blown at the end of the tube, and the gauge showed that the pressure increased until the bubble became a hemisphere when it was a maximum. It then fell as the bubble further contracted, and was reduced to equality with that of the atmosphere when the film became plane. The same result was shown by blowing two soap bubbles at the ends of two glass tubes, and, by means of stop-cocks, putting the interiors of the bubbles into communication with each other. The larger bubble was seen to swell at the expense of the smaller. Attention was then drawn to the method of forming a cylindrical bubble, and to the advantages of this form in many inquiries connected with the liquid films. Two cylindrical films, the interiors of which were put into communication, were shown to be in stable equilibrium when their lengths were less than a certain limiting value. When the limit was exceeded, one cylinder contracted while the other became barrel-shaped. A plane soap film (made of soft soap without any glycerine) was placed vertically, and exhibited to the audience by reflected light. Bands of colour rapidly appeared, and soon the top of the film became black. It was pointed out that, whereas in the coloured part of the film the tints gradually shade off one into another, the black portion is separated from the coloured part in contact with it by a sharp line of demarcation. An indication was then given of a sudden change of thickness at the boundary of the black. Newton's table of colours affords no data for estimating the thickness of this part, and hence the necessity for independent determinations. The Lecturer alluded briefly to the measurements of the thickness of the black portion of a soap film made by Professor Rücker and himself, and gave one or two experiments in illustration of the methods which had been adopted. In conclusion, the effect of passing a current of electricity up or down a soap film was exhibited, the current usually employed for producing the electric light being used for this purpose. It was seen that the effect of a downward current was to promote the rapid thinning of the film, whereas if the current was sent upwards, the colours travelled upwards instead of downwards, and the film became thicker. In either case the current appeared to carry the liquid with it.

At the conclusion of the lecture, the Chairman (Mr. Preece, F.R.S.) moved a hearty vote of thanks to the Lecturer, which was carried unanimously.

CANTOR LECTURES.

PRINCIPLES AND PRACTICE OF ORNAMENTAL DESIGN.

By Lewis Foreman Day.

Lecture IV.—Delivered December 20, 1886.

Natural Form and Ornamental Treatment.

There is no disputing the bias of the natural man in favour of nature. The Etruscans and the Moors, almost alone in the history of art, appear to have been content with ornament which was ornament pure and simple. It is not too much to say, even in these days of affected interest in things decorative, that the average Englishman neither knows nor cares anything about the subject. In most cases he is absolutely out of sympathy with it; he has probably even a sort of contempt for the "ornamental," as something opposed to the "useful," which he so highly esteems, never so much as apprehending the fact that ornamental art is art applied to some useful purpose.

The ornamental forms he most admires are the forms most nearly resembling something in nature; abstract ornament is incomprehensible to him. He begins to take a feeble interest in Greek pattern-work only when he sees in it a likeness to the honeysuckle. Show him some purely ornamental form, and it is neither its beauty, nor its character, nor its fitness that strikes him; he is perplexed only to know what it is meant to represent; as

though every form of ornament must have its definite relation to some natural object, and therein lay its interest. I say a definite relation, because a relation there must be; and that relation was at one time in some danger of being overlooked. The reaction against the artificialities and affectations of art, which characterised the early part of the present century came none too soon, and we owe all gratitude to the men who led opinion back again to the forgotten, grass-grown paths of nature.

But, now that the peril which threatened is well passed—so far passed that whatever was traditional in art is, in its turn, in danger of becoming extinct—it is time we bethought ourselves that not all of these traditions were pernicious, perhaps none of them altogether so; for whatever of perversion or degradation they may have undergone, they represent the embodiment of artistic experience during all time, and among all nations. The masters, old or new, must be presumed to have known something.

If there was at one time some fear of artificiality in art, the danger now lies in the opposite direction of literalism—a literalism which assumes a copy of nature to be not only art, but the highest form of art; which ignores, if it does not in so many words deny, the necessity of anything like art on the part of the artist, accepting the imitative faculty for all in all.

Were I to venture upon the sweeping assertion that all art whatsoever is and must be conventional, I should very likely be laying myself open to the just rebuke that I was judging all art by my own decorative standard; but with regard to ornament, I have no hesitation in saying that more or less conventional it must be, or it would not be ornamental. Not, of course, that the ornamentist denies in the least the supreme beauty of natural form and colour, or thinks for a moment to improve upon it, as they seem to imagine who taunt him with the question—"Do you flatter yourself you can surpass nature?" "Paint the lily?" and so on. Only he recognises the impossibility of even approximately copying anything without sacrificing something which is more immediately to his purpose than any fact of nature—namely consistency, fitness, breadth, repose—and is content, therefore, to take only so much of natural beauty as he can make use of. He regulates his appetite according to his digestion. This self-denial on his part is not by any means a shirking of the difficulties of the situation. In art nothing is easy, except to such as have a natural faculty that way. It is not easy to everyone to make a striking study from nature; but it does demand ability of a lesser kind to succeed in that comparatively elementary effort than to paint a picture in which there is design, unity, style, and whatever else may distinguish the work of a master of the Renaissance from that of a student of to-day.

In like manner, the mere painting or carving of a sprig of foliage is within the reach of every amateur; but to adapt such foliage to a given position and purpose, to design it into its place, to treat it after the manner of wood, stone, glass, metal, textile fabric, earthenware or what not, demands not only intelligence and inborn aptitude, but training and experience too. It is the easiest thing in the world to ridicule the conventional (if we are to use that much abused term), but it would be an awkward moment for the derider if he were asked to pause a moment in his merriment, and point out a single instance of even moderately satisfactory decoration in which a more or less non-natural treatment has not been adopted. The fact is, the artist has not yet arrived at a point where he is able to dispense altogether with art.

Those who most keenly feel the need in ornament of a quality which the modern nature worshipper delights to disparage, will be inclined to pray that they may be preserved from some of their allies. There is a class of ornament (grown, I believe, originally in the vicinity of Kensington) which appears to have originated in the idea that you have only to flatten out any kind of natural detail, and arrange it symmetrically upon arbitrary lines, and the end of ornament is achieved. But decorative design is not so easy as all that. To emasculate a natural form is not to fit it for ornamental use, and to distribute detail according to diagram is not to design. That may be conventional, but it is not the kind of convention I am upholding; one touch of nature is worth all the mechanical and lifeless stuff of that kind that ever was done. One hopes, and tries to think, that this kind of thing is dying out, if not quite dead already; but then one flatters oneself so readily that what has been proved absurd must be extinct, or moribund at least, until perhaps an enforced stay among the Philistines—say in some lodging-house parlour—brings us face to face with the evidence how very much it is alive. We have only weeded it out of our little

garden plot; about us is a wide world where it is rampant. There's no hiding it from ourselves that there's life in the old dogma yet. And it is still as necessary as ever to deny its claim to represent the due adaptation of natural forms to decorative needs. It is no more fair to take this ridiculously childish work to represent conventional design than it would be to instance the immature studies of a raw student as examples of a naturalistic treatment. Compare the best with the best. Compare the ceramic painting of Sèvres with that of ancient Greece, China, or Japan; compare the work of Palissy with that of the potters of Persia and Moresque Spain; compare the finest Aubusson carpet with a Persian rug of the best period; compare the earlier arras (such as we have at Hampton Court) with the most illusive of modern Gobelins tapestry; or the traditional Swiss wood-carving on the châlet fronts at Meyringen and thereabouts with the most ingenious model produced in the same district for the English and American tourist (who ought to know better); compare the mosaics which make glorious the domes of the baptisteries at Ravenna with the unimpressive display of Correggio (great artist though he was) at Parma; compare the peasant jewellery of almost any country except our own (we never seem to have had any) with the modern gewgaws which have taken its place: and who would hesitate to choose the more conventional art?

I am not contending for the word conventional, but for that fit treatment of ornament which folk seem agreed to call by the title, more especially when they want to abuse it. By whatever name it is called, we cannot afford to let go our hold of that something which distinguishes the decorative art of the palmiest periods, and of the most consummate masters, from the crude attempts of such as have not so much as grasped the idea that there is in art, properly so called, something more than a dishing up of the raw facts of nature.

Work as nearly natural as man can make it, though not in itself decorative, may be at times available in decoration. But forms denaturalised by men alike ignorant of the principles and unskilled in the practice of ornament, and more than half contemptuous of the art to boot, are of no interest to anyone but their authors, if even to them. Nature and art are not on such bad terms that to be unnatural is to be ornamental.

The purport of my last lecture was to show that ornamental forms should by rights be determined by the position, purpose, use, material, and mode of execution of the object in hand. It follows that these considerations must determine equally the modification of such natural forms as the designer may from time to time see fit to adopt.

Here, again, all modification must be according to the conditions of the case, not according to precedent, unless, indeed, we find that the most reasonable lines to work upon have been laid down for us already. Occasionally this may be so. I do not quite see how one is to improve much upon the best Greek rendering of the acanthus or of the ivy. So, again, the Japanese have gone far to exhaust the resources of the bamboo, the almond blossom, the peony, and certain other plants more peculiarly Oriental. Yet even in such instances (although it may well be doubted whether we can ever again treat such forms as well as they can be treated, without recalling the Greek or Japanese treatment of them), the least we can do is to try whether we cannot develop those forms, instead of merely adopting them. In very many instances, to some of which I shall allude by-and-bye, the accepted treatment is anything but adequate, that it should be allowed to lord it over our design, and say "thus far" to our invention.

The excuse, and the only excuse, for accepting time-honoured forms, is not that they are time-honoured, but that they are the best, and we cannot anyway better them. Even then, whoever is not quite without initiative of his own, will always believe in the possibility of some new thing, or, at all events, something not so egregiously trite as the venerable models of the schools. And though he fail to equal these, as well he may, we have a right to expect in his sincere expression of himself a freshness and vitality which no mere archæological reconstruction can ever have. The artist may be excused if he believe that it is neither natural fact nor antiquarian accuracy that he has to aim at, but design. Art is not quite such an artless thing as some would have us suppose.

Granting the intimate relation between nature and design, it must be granted also that nature is the starting point, and not the end of art ornamental. The grace, the growth, the flow of line, the tenderness of colour, all the subtlety of suggestion, which so delight us in ornament, would not have been evolved from man's imagination apart from natural influences; but neither does nature provide for

us ready-made ornament—or our occupation would be gone. Indeed, according to the use we make of nature, it is a help or a hindrance to us in design. Owen Jones went so far as to assert that in proportion as ornament approached to natural forms, it had less claim upon us as ornament. In that I think he went too far, much too far. It might with equal truth be contended that only in proportion as it came near to nature had it any claims upon our sympathy at all. That does not happen to be my opinion, but I am afraid it is the opinion of by far the larger proportion of Englishmen.

Fig. 21.

But how on earth, it may be asked, can nature be, in any case, a hindrance to the ornamentist. Well, mainly in the way it diverts his attention from the ornamental purpose. It has a way of claiming too much consideration for itself; and the artist has a way of yielding to the seductions of a mistress, not the one he has, so to speak, sworn to love and cherish.

The designer can hardly make too many studies from nature, but he can very easily make bad use of them. He can design quite freely only when the burden of natural fact is so familiar to him that it ceases to be a burden. An occasional reference to his studies, or to nature herself, may be refreshing enough; but to design with either in front of him, is to design under conditions of restraint not favourable to ornament.

There are two kinds of ornamental treatment, the one in which a natural type is treated ornamentally (Fig. 21), the other in which an ornamental form, suggested possibly by the material or tool employed, grows under the workman's hand into the semblance of something remembered in nature (Fig. 22). Nature modified by considerations of ornamental propriety, and ornament modified by our familiar acquaintance with nature, end in something of the same kind.

Fig. 22.

But it is with the deliberate adaptation of natural forms to the purpose of ornament that we have to do just now. The degree and kind of modification necessary cannot be arbitrarily prescribed; it will depend entirely upon the conditions of the case. The natural element

may be almost eliminated in the process of adaptation, as it is to a great extent in Fig. 21, or it may remain paramount. The degree of modification needed, or the degree of naturalness admissible, will depend not only upon the aim of the artist, but also upon the arbitrariness or naturalness of the composition. A strictly formal arrangement involves an equally formal kind of foliation, whilst natural leaves and flowers call for proportionately natural growth in the design. If, for example, it were a question of clothing a geometric skeleton with foliage, the form of the skeleton would determine the formality of the leaves. If, on the other hand, some natural form of leaf or flower were peremptory, it would logically determine the lines of the design. Rendering and arrangement should, that is to say, naturally be in keeping. But this simple principle is far from being sufficiently borne in mind. One often sees a kind of cast iron flower, reminding one of a preternaturally prim rosette, or of a catherine-wheel perhaps, with firework foliage, together with stems and stalks that have some pretensions to growth. Or you may see leaves and flowers altogether as natural as can be springing mechanically from quite arbitrary lines.

The Japanese, who render the forms of leaves almost naturally, make them grow from the stalk; the Greeks, at their best, made leaves and their attachments alike more formal; whilst the Mohammedan rendering of leafage is so remotely related to nature that one scarcely resents the deliberate way in which the principle of growth is disregarded.

Yet it is hard to reconcile oneself to the absence of something like growth, even in the most arbitrary forms of ornament. It is interesting always to be reminded of nature; and I think that the ornamentist who has any love for nature, or any knowledge of it, will, as a matter of course, make his ornament grow. Moreover, he will make it conform at least so far with nature that at all events it shall never present the appearance of an agglomeration of ill-assorted natural details. Certain features in his design may, for example, recall familiar leaves, and flowers, and fruits, and so on. But he will not associate single flowers with fruits that grow in clusters, catkin blossoms with seeds in pods, woody leaves with tender twining stalks, nor tendrils with the growth of a forest tree. According to his acquaintance with nature, he will abstain, instinctively, from all such incongruities. I know that the artists of the later Renaissance made all manner of flowers and fruits grow inconsequently from a single stalk; but I am not prepared to accept the artists of the later Renaissance (for all the masterly ability of some of them) as safe guides in the matter of taste; nor, indeed, to accept any precedent that cannot justify its claims to our respect. Let every precedent be stripped of its prestige, and as strictly looked over as the newest of recruits, and let the ricketty ones be dismissed with thanks. The accepted precedents are not all sound.

I should say, for instance, that though there is much to be learnt from the Gothic rendering of flower forms and foliage, it by no means solves for us the whole problem of conventional treatment. The vine was treated in the middle ages with a simplicity and breadth worthy of all respect, but without great appreciation of the characteristic vine forms. The inevitable regularity of the "ecclesiastical" grape clusters becomes eventually wearisome, and the accompanying tendrils have seldom any very close relation to the forms of nature, which, nevertheless, are admirably ornamental in their growth.

The Tudor rendering of the rose is in many respects masterly. I doubt if it can well be improved upon. But the seed vessels of the plant have been turned to surprisingly little account in design; and so have the thorns, again, though they invite an ornamental treatment, which, so far as I know, has not been attempted.

The Gothic lily is represented not unfrequently with five petals, so little is it studied from nature, and there is seldom much recognition in Mediæval work of that peculiar wiry twist of the leaf which is so characteristic of the plant (Fig. 23, p. 137). The symbolic passion-flower, again, is always rather tame; its tendrils are only remotely like nature; and the broad, distinctive stipules of the leaves, decorative though they be, are turned to no account.

A propos of the passion flower, it should be observed that obviously elegant and graceful forms of growth, such as the passion flower, the convolvulus, the fuchsia, the birch tree, and so on, do not as a matter of course lend themselves most kindly to ornamental treatment. Sometimes it seems as though the contrary were the case, just as it is not exactly in romantic or what is called picturesque scenery that the landscape painter finds the best subjects for pictures.

The Japanese treatment of plant form is always more characteristic. The artist evi-

dently goes straight to nature for his inspiration, and though he indulges sometimes in angular and ugly forms, there is always a decorative as well as a natural quality in his design. He knows, indeed, how in season to compel all natural forms whatsoever to submit to decorative needs. He can be on occasion most uncompromising in the way he will sacrifice nature to his purpose, but it is obvious always that it is not from ignorance or incapacity that he makes the sacrifice. The conventionality of his treatment is the outcome and the evidence of the supremacy of the decorative instinct in him.

FIG. 23.

Though nothing can well be more ingenious than the way in which a Japanese will adapt a natural form to any ornamental purpose, the forms he indulges in are, as I said, by times more characteristic than beautiful. The reverse is the case with certain 16th centuy Italian adaptations of floral form. You see, for example, the ornamental rendering of familiar flowers, in which the original is endued with a grace of line, and a general suavity of form, not characteristic of, and probably not to be found in, the natural growth of the plants themselves. This is all in the right direction—in the direction of ornament, that is to say. But still, if the forms are very like nature, one somehow misses the natural characteristics of the plants, and the effect is not *quite* satisfactory. The Italian treatment of the lily (Fig. 24) is more graceful than literally natural.

The question arises then, as to how far one is bound to adhere to the lines which a plant naturally takes. Obviously, the simplest plan is, to select such forms as are at once most

FIG. 24.

characteristic and most ornamental. They are often identically the same; where they are not, then one would say, choose at least those characteristic forms which do lend themselves to ornamental treatment. Were we to select only forms readily amenable to ornament, all difficulty would be anticipated. But it must be remembered that many of these accommodating forms have been, as we may say, appropriated, and have become so hackneyed

as to have lost no little of their charm. How can we treat the trefoil, the lily, or the rose, without recalling the stock patterns of the church furnisher?

Certain "ecclesiastical" forms, as they are called, have become (not, perhaps, without reason in the first instance) so terribly familiar, that it is almost impossible to shake off the tyranny of the traditional rendering. Even then there is usually, as I have said, something left for us in the way of development. It is seldom that a subject has been sucked quite dry, whatever the traditional drain upon it. For example, we have grown rather sick of the sunflower, it has been used and abused so unmercifully; but little notice has been taken in ornament of the very sportive way in which it throws out occasional leaves from its involucre (or what looks like the calyx of the flower), in a manner admirably corrective, in its very friskiness, of the rather formal growth of the flower. Nor has due advantage been taken of the variety afforded by the back view of the flowerhead; and so with many another well-worn type. The travesty of certain forms, if not the familiarity with them, has led to a certain impatient contempt of anything of the kind. One is fain, therefore, to seek some new thing, and is driven ever further and further afield from the obviously available shapes.

Moreover, there occur cases in which, for symbolic or other reasons, quite apart from ornamental considerations, but none the less imperative, some particular, and perhaps particularly awkward plant is given us, to do the best we can with it. In such a case one may possibly correct the contrariness of its growth by intertwining with it some other plant which is, so to speak, complementary to it, and by means of which one may secure that grace, balance, breadth, or other ornamental quality, which without it would be hopeless (Fig. 25).

The supplementary forms introduced need not of necessity be floral. The convenience of bird forms, butterflies, &c., is obvious — so obvious as to have been too readily accepted as a means to a not very ambitious end. It is preferable at least that any creatures introduced should have some *raison d'être* beyond that of just filling a gap. Nature herself often gives a hint to the designer. Notice for yourself the flowers which attract the bees, and do not make them dive for honey where there is none to get. And so with butterflies, what flowers they affect. I was noticing this autumn how the common broom, whose foliage is so diminutive as to go for little, was dotted over, after a shower of rain, with dainty little snails, whose delicately marked shells formed quite a feature in the pattern of the shrub. And, since it is ornament we are discussing, let me

FIG. 25.

digress for a moment to the consideration of shells—how exquisitely they are ornamented, and how little has been made of shell-forms generally in ornament. The mine of sugges-

tion in the cockle or scallop shell has been worked out, indeed; but designers have sought no further, perhaps because of the supposed obligation of working in a given "style." You have but to use the accepted shape, and your work is accepted, for Renaissance let us say, but the introduction of a snail shell, a mussel, a limpet, or a barnacle, would be questioned, and possibly resented. It is true that the chosen shell was probably the one most useful in ornament, but its symbolism has ceased to have much meaning for us, and *toujours* cockle shell begins to get stale at last.

To return to natural form not in itself readily amenable to ornament, it is a simple expedient to associate with it objects more purely ornamental—scrolls, ribands, labels, and the like—as the Italians and their French followers very generally did, and so make sure of the lines you want in your design. But this is to evade the difficulty rather than to master it.

The question is how, without eliminating the natural element, to make natural forms subservient to decoration. The boundary line between the natural and the ornamental is not by any means a hard and fast one. The adherents of either side are continually encroaching on the domain of the other; the one party claims more for nature, the other more for art, that is all. The one would shift the line a little further in this direction, the other in that. It is only a question of rectification of frontier; but it is none the easier settled for that.

With regard to the actual lines of design when the choice is between the natural and the ornamental, the better plan appears to be rather to persuade the natural and characteristic growth into lines more in harmony with ornamental purposes, than to take merely arbitrary or accepted lines, and proceed to clothe them with leaves and flowers from nature. The Greeks did, I am afraid, sometimes in the days of their decadence adopt the latter device, but that does not justify it or make it right, and they did not more than half succeed. It is only when the leaves are equally remote from nature with the lines connecting them that their arbitrary connection ceases to be unsatisfactory. The mere scroll with its leaves alternately on either side (or leaves and flowers, or leaves and berries) is objectionable just in proportion to the naturalistic rendering of the leaf, flower, berry, or whatever it may be.

The acanthus scroll, whether Greek, Roman, or Renaissance, is clothed with foliage very happily reduced to a condition as ornamental as the lines on which it grows. And if you adopt a spiral, wave, or other set line, you are bound in consistency to make its foliation proportionately removed from nature. In Oriental border patterns the paramount importance of ornamental consideration is everywhere observed; lines and leaves are equally remote from actual natural growth. But what is to be done when something like natural representation is sought, and yet the lines of growth peculiar to the chosen plant are not precisely in the direction of ornament?

There is a certain beauty in the stiff growth of the already mentioned lily, and it may sometimes be well to retain this characteristic. But it is stiff, and the ornamentist may fairly seek his lines of growth more graceful. Still he should scarcely make it branch like a shrub or twine like a creeper. Some familiarity with the natural growth, and sufficient practice in ornamental design, will, together, probably suffice to suggest to him lines, graceful enough, which yet do not contradict the natural growth, and which, perhaps, even recall it, although the possibility will depend, to some extent, upon the proportion of the space he has to occupy.

So, in rendering the peculiar twist of the leaves (to which I have once before referred) it is not beyond the resources of the ornamentist to suggest this peculiar but sometimes angular and even ugly growth in a manner more ornamental. This indeed is accomplished in some painted presses in the sacristy of S. Pietro, at Perugia, (*not* Fig. 24) where the lily takes preternaturally graceful and flowing lines, and is, in fact, almost pattern-like in its growth, whilst it nevertheless does distinctly recall the growth of the plant, and was obviously studied from it. It is evident, in short, that the artist looked at the flowers for himself, and conventionalised them according to his needs.

This the natural evolution of ornament, as distinct from the distortion of nature which is mistaken for ornamental treatment.

Whilst insisting upon the necessity of some modification of natural forms, then, I would insist no less that the modification should be our own. The "traditional" is something to be squeezed for our nourishment, not dried for our imitation. We are too ready to adopt traditional forms, as though all necessary modification had been done for us beforehand. But no good work was ever done in that way.

The modification was always in reference to the thing to be done, and there was a much more constant reference to nature than we are accustomed to suppose. In our modern affectations we are so much more Gothic than the Goth, so much more classic than ever the Greek was. I have seen Greek foliage (for example in the Louvre) which, if one had done it nowadays for Greek, would certainly have been accused by the purist of betraying Gothic, or even Japanese, influence. There is a variety even in the antique very much at variance with the stereotyped character which passes muster with us for classic.

The place of *accident* in reference to design appears at first sight easy enough to define. Is not accident, as its name implies, the very antithesis of design? And yet it is to some extent owing to the elimination of what is accidental in nature, that conventional ornament, like academic figure-work, is so tame and insipid. The orthodox is undeniably dreary.

But this dreariness is not the unavoidable result of due selection on the part of the designer, but of his adopting a ready-made selection, the very meaning of which has no real significance to him individually. Design implies invention; and accident is at all events prolific of suggestion to the inventor.

The designer, no less than the most aggressive realist, should, in his own way, take every possible advantage of the accidental in nature, of every accident which is suggestive to him of characteristic, beautiful, or useful design; not, of course, of the merely ugly or repulsive deformity which others have, for obvious reasons, weeded out of their borders. For ornament is the product of a garden, not of a wilderness. If, on the one hand, it may be found too formal in character, on the other, there is a danger that it may be allowed to run too wild. The fear of over-culture is not an excuse for allowing it to run to seed. Art depends on cultivation, and ornament is just nature trained in the way it should go.

In conventionalising floral forms, there is some fear of a formality similar to that affected by the typical gardener, whose idea is not in the direction either of art or beauty. The types of the florist are excellent examples of what *not* to do in the way of modifying nature. Look at the dahlia as the gardeners have made it. It is beautiful only in respect to colour; but if you observe the bud in its various stages, to which attention has not been directed, you will find shapes much more natural, much more beautiful, and quite peculiarly adapted to ornament. The elimination of whatever is wayward, characteristic, and uncommon, is *not* advisable on any account whatever. To reduce a flower to the likeness of a rosette is not necessarily to make it more ornamental; and any accident which shows a return to nature is welcome as a relief from such—shall I say academic?—evenness of form. Nature is fruitful of such accidents. Did you never notice how the poppies in the corn hardly ever get over the crick in the neck, which comes of their hanging their heads so long in the heavy bud state? There is always a tell-tale nick in the stalk of the full-blown flower, still more plainly to be seen when the petals have dropped off, and the seed vessel is left naked. It does not stand up straight and stiff, like a barrel on a pole.

The geometric order of the floral parts does not in nature result in the mechanical effect so often seen in our attempts at ornament. If the leaves spring at somewhat regular intervals—they do spring. Notice the way many leaf-stalks thicken at the point of junction with the stem, as in the sycamore; or how the stalk itself is often pulled out of the straight, as it were, by the leaves, as in the lime; how the stipules enrich the meagre joint, as in the thorn; or wrap it round and mask it, as in the fennel and all manner of grasses. The horticultural ideal is the evenest of all possible flower-heads, a spike of blossoms as trim as a clipped yew tree or a French poodle; but nature indulges very rarely in that cheap kind of symmetry, and when the spike itself is very regularly shaped, the actual blossoms have a way of shooting out more or less casually and accidentally. This is very noticeable in the salvias, for all the gardener's pains with them. In the woods you see everywhere what variations nature plays upon a symmetrical plan. This is all to show how order is not in any way dependent upon evenness—not to show that nature does the ornamentist's work for him.

As a protest against unintelligent artificiality one may welcome even rusticity; but one wearies of mere reactionary realism. The needful thing is to go to nature, and to choose for yourself; but the choosing is as essential as the going to nature, and the choosing not only of natural types, but of the accompanying accidents, in so far that they may be serviceable in ornament. Who does that may stray from

nature as far as he pleases; his work will not be vapid or uninteresting to any one at all interested in ornament.

Let me illustrate more fully what I mean by accidents available in ornament. Did you ever notice the way an apple tree blossoms? Not only are the buds arranged upon a formal plan, but it happens that the topmost flower blossoms first; so that, as a very frequent result, we see a single open flower nestling among pink buds. Nothing could well be more ornamental than that pale, central, five-petalled flower, encircled by a series of five pink balls. And then, if you examine those compact little balls, how admirable the folding of the petals is marked; you could not invent lines more absolutely graceful. In the similar but larger bud of the common peony one seems, by the way, to see the origin of the Norman "ball-flower." To treat a flower adequately one has to watch its growth, and seize the moment favourable to ornament. It is not enough even to observe a plant throughout the season. In many cases it is seen to advantage only in certain years, when the season chances to favour a development more suggestive of ornament than usual.

In a wet season, for example, when things grow quickly, the ordinarily confused effect of many plants is done away with. The stalks being longer, and the features further apart, the growth explains itself. It has, in fact, been simplified by natural causes; and adaptation to ornamental purpose is often little more than simplification.

You may have noticed, now and again, where a young oak tree has been cut down close to the root, and it has shot out a ring of young shoots all round it, so that it had all the appearance of an exceptionally perfect wreath of oak leaves on the ground. A few days later, and that effect would be lost, and the designer of an oak wreath would find no living, growing model to work from.

Again, what a difference it makes, and it depends very much upon the season, whether the sepals of the flower remain on the ripened fruit (witness the medlar or the hip of the rose), or whether the stipules at the base of the leaf-stalk, and the bracts at the axels of the flower stalks, adhere or wither and fall off, which also is very much a question of the season. Then, certain fruit trees in certain years begin to bloom again whilst the ripe fruit is yet on the tree.

The bursting of the full pomegranate fruit has been made use of in ornament, for reasons as much of symbolism as anything else; but what a numberless variety there is of seed-vessels whose opening is suggestive of ornament. The spindle-berry occurs at once, the seed-vessel of the garden plant called honesty, the pods of the iris, the pea, and all kinds of vetches. Even the dried husks, out of which flowers and seeds alike have fallen, are often delightfully ornamental.

It is noteworthy, again, how, for example, in the oak, the acorns fall, and the empty cup lends itself to fresh forms of ornament; how there is usually at the end of the fruit stalk a withered little button or two, which never arrive at due development; and how the gall-fly comes to the help of the artist, and furnishes him with what is as good as a second fruit form, which grows, too, in places where fruits would never be. The feathery burr that besets the rose and other plants is equally suggestive.

It is necessary, of course, to know the system upon which each particular plant grows; but nature is not always quite so careful to emphasise the fact as is the botanist. I am not scientific enough to say how far natural forms are actually modified by nature for the occasion; but I know that, under certain conditions, not uncommon, plants seem to grow differently from what botanically we have been taught to expect. Thus, where there is no room for leaves to grow alternately or spirally they will spring out all from one side. I once made a note of six or seven consecutive leaves of the passion flower, all springing apparently from one side of the stem. Had I ever taken that liberty in ornament, I should have been told that it was pure convention.

In the accidental twist and turn of the leaves of a plant there is always something to be learnt; and, somehow, the same accidents happen to the same plants, and not indiscriminately to all. There is doubtless always good structural reason for the peculiarity, if we looked deep enough for it.

No feature of flower growth has been more badly treated than the tendril. Artists have thought themselves free to add a tendril to any plant whatsoever, and wheresoever they wanted it. And what tendrils! The poets of another generation were wont to compare the tresses of their lady-loves to the tendrils of the vine; and there is sometimes a corkscrewy look about the two which might justify the comparison. But what a lively corkscrew is the tendril! How gaily it starts

on a second lease of life, and how varied it is! How ornamentally it twists and twirls about—how it gropes for something to catch hold of, and how vigorously the full-grown tendril contrasts with the tender, silky growth of the young shoots. And then how different is the branched tendril of the vine from that of the common pea; how different both from the simple briony tendril.

The twining character of the bind-weed, hop, and such like plants, has suggested, to artists who look without their eyes, that they must have tendrils to hold them up, and with tendrils accordingly they provide them, neglecting the essentially ornamental character of the twining stem. So, too, the suckers by which the ivy and the Virginia creeper attach themselves have been overlooked, and impossible tendrils invented. Equally ignored in ornament are plants such as the clematis and nasturtium, attaching themselves by their leaf-stalks, which fasten in the most ornamental fashion on whatever they can lay hold upon.

Comparatively slight decorative use has been made of the stipules of leaf-stalks, which, for example, in the pea, the passion flower, and the sow-thistle, assume distinctly ornamental proportions. But even in the less marked form in which they appear—say the medlar, the hop, the common nettle, &c.—they are useful in ornament; as might also be the *scars* left by the fallen leaves, with which at times the stems of certain trees, such as the horse-chestnut, are naturally decorated.

It is strange that the leaf-bud has not received more general attention in ornament. Occurring as it may at the axel of any leaf, it affords, together with the incipient shoot, a most convenient means of filling the empty angle between the leaf-stalk and the stem. The young shoot also gives an opportunity of contrasting with the larger forms of the design details on a smaller scale — an opportunity invaluable in design. You see this very markedly in the chrysanthemum and in some of the solanums. By the way, not nearly enough notice has been taken of the manner in which the colour of the flower-stalks is very often more in harmony with them than with the leaves—as in the bigonia, salvia, sea-thistle, and many others. We are too much disposed to take it for granted that the flowers are red, blue, white, yellow, purple, and leaves and so on green. But the leaf-stalk is sometimes bright crimson, as in the little wild geranium and the sycamore, or brilliant yellow, as in the case of some poplar leaves. Leaves themselves are often anything but green. I don't mean that they are merely greyish, as in the corn flower, or olive, which they seldom are; or that they change colour as they fade in autumn; but that they are rose or madder coloured, as in the late shoots of the oak, briar, hornbeam, &c. And then, again, the variety there is in the backs of leaves—purple, as in the wild lettuce; rich red brown, as in some magnolias and rhododendrons; silver grey or white, as in certain alders, poplars, and willows, and some garden plants.

The Japanese have made the frankest possible use of this feature. They will deliberately make the turn-over of a black leaf white, or sketch its reverse only in outline, always with admirable decorative instinct. But it is impossible to point out at further length all the various ways in which nature throws out hints to the ornamentist; they are as multiform as nature herself.

I have said that to conventionalise is often but to simplify; thus the character of Early English (13th century) foliage is so simply Early English, that it is open to dispute which trefoil form suggested it; none of them, very likely. It grew most probably out of Byzantine forms, themselves derived from the classic acanthus; and it was only when they had arrived, through symbolism, at something suggestive of clover, or wood sorrel, or hypatica, that the carvers took to making the symbol yet more like a natural growth.

But in very many instances, undoubtedly, the simple necessity of simplifying the natural form was the reason for its conventional treatment. The omission of the superfluous is, obviously, so far right. How far it may be desirable to add to a natural form characteristics which do not belong to it is more open to question. For my part, I am not disposed to quarrel with the invention of the Tudor rose, nor with the *flamboyant* character of later Gothic foliage; though I am bound to admit that the bedecoration of natural forms (as we see, for example, in some Perpendicular carving) is dangerous, if we wish at all to preserve the natural character of its original. If our purpose is mere ornament, then we are comparatively free. But it is worth bearing in mind that it is always better to suggest growth than frilling in any addenda we may make.

Whatever the liberty to be claimed in this respect, it is distinctly a mistake in taste to

give, as the late Gothic carvers did, to leaves in wood or stone the bulbous look of beaten metal work.

There would seem to be in nature some sort of precedent even for the artificial befrilling of floral forms. There is a particular kind of crinkled cabbage, which looks as if the milliner had taken it in hand. Certain ferns grow with every appearance of artificiality. And I came not long ago upon a little wild flower, unknown to me by name, looking for all the world as if it must have been designed somewhere about A.D. 1500.

There are various ways, then, of modifying natural forms. Apart from the consideration of the circumstances of the case in point, we have for our guidance, or for our warning, the ways in which natural forms have till now been manipulated by the ornamentist. There is the graceful Greek way, and the energetic Japanese; the rigid Gothic, and the more strict Egyptian manner; the fanciful Chinese, and the suave Persian; and again the manners of the Renaissance from the 15th century to the 18th.

The most naturalistic type is afforded by the Japanese. They start so frankly from nature, and yet they are so careful of the conditions of decoration, that one scarce knows which is uppermost in their minds, nature or ornament. I fancy they went pretty simply to work, and copied nature as nearly as their tools and the general conditions allowed, conventionalising, so to speak, as the circumstances suggested, or the tools demanded. but they never lost sight of the fact that they were decorating something—that would have been fatal. I do not mean to say that Japanese ornament is in every way perfect; it lacks many qualities which are indispensable to us; but in the mere treatment of natural form as naturally as possible, and yet ornamentally, there is probably more to be learnt from Japan than from any other source. The stained glass window-pane (Fig. 26) shows both Japanese and Gothic influence.

In the more essentially ornamental treatment of forms borrowed from nature the Greeks excelled, as they did in most else. The Corinthian capital, or the acanthus scroll, as they carved it, is perfect. Unfortunately, we have been too content to copy their forms, instead of trying to conventionalise in their manner.

In Eastern art, Indian, Persian, and Chinese, there is again a great deal to be learnt; if only we would borrow their art, and not simply the Oriental forms. Once more, our art ought to be ours.

It is easy for any one who is susceptible to the beauty and charm of nature (and the artist, of all men, must be supposed to have that susceptibility) to understand how many persons feel a kind of resentment at the very idea of interference with nature. To disturb it is to deform it, no doubt; but in the interest of cultivation it has to be done. Brier, and bracken, and golden gorse, must give place to apple orchards, rose gardens, and fields of

FIG. 26.

corn. They, too, are beautiful; not the less so that they owe something to the hand of man. It is, after all, a false and rather a cowardly sentiment which makes us afraid of disturbing what is beautiful, even for the sake of a beauty better worth having.

Those who profess to follow nature seem sometimes rather to be dragging her in the dust. There is a wider view of nature, which includes human nature, and that selective and idealising instinct which is natural to man. It is a

long way from being yet proved that the naturalistic designer is more "true to nature" than another. It is one thing to study nature, and another to pretend that studies are works of art. In no branch of art has it ever been held by the masters (least of all could it be held by the masters of ornament) that nature was enough. Only the green student is overpowered by the model before him; the mature artist shows his mastery by making it subserve his purpose. The beginner may condescend to "crib"—the artist conceives. It is the rustic who says, "Lor, how natural!" The connoisseur thinks to himself, "what perfect art!"

I have now come to the end of this short series of lectures. It has been impossible, of course, to give you much more than a glimpse of a subject so wide as that of ornament. I cannot flatter myself that, in four short hours, I have taught any one of you much. But if I have aroused any interest in the subject which so deeply interests me, or given encouragement to any, I shall have done all that I had any hope of doing.

Miscellaneous.

IMPERIAL INSTITUTE.

On Wednesday afternoon, H.R.H. the Prince of Wales presided at a meeting of noblemen and gentlemen specially invited to consider the means of carrying out arrangements for the proposed Imperial Institute of the United Kingdom, the Colonies, and India, which was held in the Banqueting-room of St. James's Palace. The PRINCE OF WALES said:—My Lords and Gentlemen,—You are doubless aware of the general feeling on the part of the public that some signal proof of the love and loyalty of her Majesty's subjects throughout her widely extended Empire should be given to the Queen when she celebrates the 50th year of her happy reign. In order to afford to the Queen the fullest satisfaction, the proposed memorial should not be merely personal in its character, but should tend to serve the interests of the entire Empire, and to promote a feeling of unity among the whole of her Majesty's subjects. The desire to find fitting means of drawing our Colonies and India into closer bonds with the mother country, a desire which of late has been clearly expressed, meets, I am sure, with the Queen's warmest sympathy. It occurred to me that the recent Colonial and Indian Exhibition, which presented a most successful display of the material resources of the colonies and India, might suggest the basis for an institute which should afford a permanent representation of the products and manufactures of the whole of the Queen's dominions. I therefore appointed a committee of eminent men to consider and report to me upon the best means of carrying out this idea. Upon the report of the committee being submitted to me, and after giving every clause my full consideration, it so entirely met with my approval, that I accepted all its suggestions, and I therefore directed that a copy of that report should be sent to each of you. As I trust you have mastered the suggestions of that report, I do not purpose re-stating them to you in detail, but I would remind you that I propose that the memorial should bear the name of the Imperial Institute of the United Kingdom, the Colonies, and India, and that it must find its home within buildings of a character worthy to commemorate the jubilee year of the Queen's reign. My proposals also are that the Imperial Institute should be an emblem of the unity of the Empire, and should illustrate the resources and capabilities of every section of her Majesty's dominions. By these means every one may become acquainted with the marvellous growth of the Queen's Colonial and Indian possessions during her reign, and will be enabled to mark, by the opportunities afforded for contrast, how steadily these possessions have advanced in manufacturing skill and enterprise, step by step with the mother country. A representative institute of this kind must necessarily be situated in London, but its organisation will, I trust, be such that benefits will be equally conferred upon our provincial communities as well as upon the Colonial and Indian subjects of the Crown. It is my hope that the institute will form a practical means of communication between our colonial settlers and those persons at home who may benefit by emigration. Much information, and even instruction, may beneficially be imparted to those who need guidance in respect to emigration. You are aware that the competition of industry all over the world has become keen, while commerce and manufactures have been profoundly affected by the recent rapid progress of science, and the increased facilities of inter-communication offered by steam and the electric telegraph. In consequence of these changes all nations are using strenuous efforts to produce a trained intelligence among their people. The working classes of this country have not been slow to show their desire for improvement in this direction. They wish to place themselves in a position of intellectual power by using all opportunities offered to them to secure an understanding of the principles as well as of the practice of the work in which they are engaged. No less than 16,000,000 persons from all parts of the kingdom have attended the four exhibitions over which I presided, representing fisheries, public health, inventions, and the Colonies and India, and I assure you I would not have undertaken the labour attending their administration, had I not felt a deep conviction that such exhibitions added to the know-

ledge of the people and stimulated the industries of the country. I have on more than one occasion expressed my own views, founded upon those so often enunciated by my lamented father, that it is of the greatest importance to do everything within our power to advance the knowledge, as well as the practical skill, of the productive classes of the Empire. I therefore commend to you, as the leading idea I entertain, that the institute should be regarded as a centre for extending knowledge in relation to the industrial resources and commerce of the Queen's dominions. With this view it should be in constant touch, not only with the chief manufacturing districts of this country, but also with all the colonies and India. Such objects are large in their scope, and must necessarily be so, if this institute is worthily to represent the unity of the Empire. To some minds the scheme may not be sufficiently comprehensive, because it does not provide for systematic courses of technical instruction in connection with the collections and libraries of the proposed institnte. I would be the last person to undervalue this suggestion. I am well aware that the advantages we have enjoyed in the competition of the world by the possession of fuel, combined with large mineral resources and by the maritime habits of our people, are now becoming of less importance, as trained intellect has in other countries been more and more applied to productive industry. But I know that this truth has already penetrated our centres of manufacturing activity, for many of the large towns have founded colleges and schools of science and art to increase the intellectual factor of production. London, also, has taken important steps in the same direction. The Imperial Institute should be a supplement to, and not a competitor with, other institutions for technical education in science and art both at home and in the colonies. At the same time, I trust that the institute will be able to stimulate and aid local efforts by directing scholarships for the working ciasses into suitable channels, and by other means. Though the institute does not engage in the direct object of systematic technical education, it may well be the means of promoting it, as its purpose is to extend an exact knowledge of the industrial resources of the Empire. It will be a place of study and resort for producers and consumers from the colonies and India when they visit this country for business or pleasure, and they, as well as the merchants and manufacturers of the United Kingdom, will find in its collections, libraries, conference and intelligence rooms, the means of extending the commerce and of improving the manufacturing industries of the Empire. I trust, too, that Colonial and Indian subjects visiting this country will find some sort of social welcome within the proposed building. This institute will thus be an emblem, as well as a practical exponent, of the community of interests and the unity of feeling throughout the extended dominions of the Queen. From the close relation in which I stand to the Qneen, there can be no impropriety in my stating that if her subjects desire, on the occasion of the celebration of her 50th year as Sovereign of this great Empire, to offer her a memorial of their love and loyalty, she would specially value one which would promote the industrial and commercial resources of her dominions in various parts of the world, and which would be expressive of that unity and co-operation which her Majesty desires should prevail among all classes and races of her extended Empire. My lords and gentlemen, I have invited you to meet on this occasion in order that I may appeal to you to give me your assistance in establishing and maintaining the Imperial Institute. If you approve of the views I have expressed, I am certain I may rely upon your strenuous co-operation to carry them into effect. I admit that it has not been without anxiety that I resolved to make the propositions I have submitted to you, but confidence and support come to me in the knowledge that I can appeal to you, and through you to the whole country, to give your aid to a work which I believe will be of lasting benefit to this and future generations.

The first resolution proposed by Earl SPENCER, seconded by the LORD PROVOST OF EDINBURGH, and carried unanimously, was as follows:—"This meeting is of opinion that the foundation of an Imperial Institute for the United Kingdom, the Colonies, and India would—as an emblem of unity of the Empire, and as an exponent of its industries and commercial resources—be a national memorial fitting and worthy to commemorate the completion of the 50th year of her Majesty's reign."

The second resolution was proposed by Earl GRANVILLE, seconded by the LORD MAYOR OF YORK, and carried unanimously:—"That an appeal be made to the subjects of the Queen throughout her Majesty's dominions to give a generous support to the establishment and maintenance of such Imperial Institute."

The third and concluding resolution was proposed by the LORD MAYOR OF LONDON, seconded by the MAYOR OF NEWCASTLE, and carried unanimously: —"That the best thanks of this meeting be expressed to his Royal Highness the Prince of Wales, for his exertions in framing and presenting the scheme of an Imperial Institute, which, in the opinion of this meeting, will, if established, confer great and important benefits on the subjects of the Queen."

A numerously attended public meeting, in support of the scheme of the Imperial Institute, was held later in the afternoon of the same day, in the Egyptian-hall of the Mansion-house, the Right Hon. the Lord Mayor in the chair. Resolutions proposed by Earl Granville, Mr. Plunket, M.P., the Chancellor of the Exchequer, Mr. Mundella, M.P., Lord Rothschild, Professor Huxley, Sir John Lubbock, the Marquis of Lorne, and Sir Charles Tupper, were carried.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

January 19.—"Cameo Cutting as an Occupation." By J. B. Marsh. Francis Cobb, Treasurer of the Society, will preside.

January 26.—"Photographic Lenses." By J. Traill Taylor. James Glaisher, F.R.S., President of the Photographic Society, will preside.

Indian Section.

Friday evenings, at Eight o'clock:—

January 21.—"The Upper Oxus." By Trelawney Saunders. Malcolm Low, M.P., will preside.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

January 25.—"New Zealand Scenery." By Kerry Nichols. Sir Francis Dillon Bell, K.C M.G., C.B., will preside.

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

February 1.—Opening Address on "The Condition of Applied Art in England, and the Education of the Art Workman." By T. Armstrong, Director of the Art Division, Science and Art Department. Sir George Birdwood, M.D., LL.D., C S.I, will preside.

Cantor Lectures.

The Second Course will be on the "Diseases of Plants, with special reference to Agriculture and Forestry." By T. L. W. Thudichum, M.D. Three Lectures.

January 24, 31; February 7.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 17...Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Announcement of Awards of Medals and Prizes for Designs, Essays, &c.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p m. Mr. W. St. C. Boscawen, "New Assyrian Discoveries."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. H. Flower, "Fins, Wings, and Hands."

Tuesday, Jan. 18...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p m. 1. Mr. G. B. Howes, "On the Fin of *Ceratodus*." 2. Prof. T. Jeffery Parker, "Notes on *Carcharodon rondeletii*." 3. Messrs. H. B. Brady, W. Kitchen Parker, and T. Rupert Jones, "On some Foraminifera from the Abrohlos Bank."

Wednesday, Jan. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. B. Marsh, "Cameo cutting as an Occupation."

Meteorological, 25, Great George-street, S.W., 7 p.m.

Entomological, 11, Chandos-street, W., 7 p m. Annual Meeting.

Archæological Association, 32, Sackville street, W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. F. Campin, "The Design of English and Foreign Bridges."

Tuesday, Jan. 20...Froebel Society (at the House of the Society of Arts), 8 p.m.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Messrs. F. Darwin and A. Bateson, "Stimulation on Turgescent Vegetable Tissues." 2. Rev. T. Hinckes, "Hydroids and Polyzoa of Mergui Archipelago." 3. Mr. J. R. Vaizey, "Tissues of Sporophore in Mosses."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. J. Emerson Reynolds, "Some new Silicon Compounds and their Derivatives." (I. The Action of Silicon Tetrabromide on Thio-carbamide.) 2. Mr. Emil A. Werner, "Derivatives of Chromo-Organic Acids." (I. Certain Chromoxalates.) 3. Dr. A. K. Miller, Remarks on Bayer's paper, "The Constitution of Benzene."

Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W., 5 p.m. Mr. M. Ogle Tarbotton, "Engineering and Architecture in relation to Sanitary Science."

London Institution, Finsbury-circus, E.C., 6 p.m. (Juvenile Lecture.) Dr. C. Meymott Tidy, "Chemical Action." (Lecture III.)

Society for the Encouragement of Fine Arts, 8 p.m. Conversazione at the Galleries of the Royal Institute of Painters in Oil Colours, Piccadilly, W.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. W. Rücker, "Molecular Forces." (Lecture I.)

Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Friday, Jan. 21...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Sir William Thomson, "The Probable Origin, the Total Amount, and the Possible Duration of the Sun's Heat."

Philological, University College, W.C., 8 p.m. Dr. J. A. H. Murray, "A Dictionary Evening."

Saturday, Jan. 22...Royal Institution, Albemarle-street, W., 3 p.m. Mr. C. Armbruster, "Modern Composers of Classical Song—Liszt." (With Vocal Illustrations.)

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. Herbert Tomlinson, "The Permanent and Temporary Effects on some of the Physical Properties of Iron, produced by raising the temperature to 100°C. 2. Prof. Unwin, "Some New Measuring Instruments used in Testing Materials."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 1,783. Vol. XXXV.

FRIDAY, JANUARY 21, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

The Council met as a committee on Wednesday, 19th inst., to consider the best means of obtaining subscriptions for the Imperial Institute, in accordance with the desire of H.R.H. the President, as expressed in his letter to the Chairman of the Council, printed in last week's number of the *Journal*.

The Council have resolved to appeal to the members of the Society for subscriptions to a special Society of Arts Fund for the purpose. Full particulars will shortly be sent to each member of the Society, and will be published in the *Journal*.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Two Gold Medals and Four Silver Medals for prime movers suitable for electric-light installations.

The medals will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class.

(A.) Motors in which the working agent is also produced (steam and gas engines).

(B.) Motors in which the working agent must be supplied (steam, gas, and hydraulic engines).

Each class will be subdivided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p.

The entrance fee will be £2 10s. per h.p., to be paid on entry.

The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

The full statement of the conditions under which the medals are offered can be obtained on application to the Secretary, and will be found in the number of the *Journal* for December 17.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

THE JOURNAL.

The Secretary will be greatly obliged if the members of the Society will inform him at once of any irregularity which may occur in the delivery of the *Journal*.

Proceedings of the Society.

SIXTH ORDINARY MEETING.

Wednesday, January 19, 1887; Francis Cobb, Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Beamish, Major A. A. W., R.E., 28, Grosvenor-road, S.W.
Blomfield, Reginald T., M.A., 39, Woburn-square, W.C.
Brevitt, Horatio, The Leisures, Tettenhall-road, Wolverhampton.
Coates, William Thomas, 24, St. Martin's-road, Stockwell, S.W.
Crow, Arthur, Ely-house, Carnarvon-road, Stratford, E.
Docwra, John William, Clumber-house, The Ridgeway, Enfield.
Geen, Charles, Hillside, Okehampton.
Graveley, George, "Cheops," Cambridge-park, Wanstead, Essex.
Gray, Edward James (Alderman), 37A, Mincing-lane, E.C., and The Hermitage, Snaresbrook, E.
Hamilton-Gordon, George William, 72, Finsbury-pavement, E.C., and The Close, Salisbury.
Hammond, Charles Pollard, 28, Warwick-street, New-cross, S.E.
Haynes, W. H., 135, Alexandra-road, N.W.
Heald, Simpson C., Worcester, Massachussetts, U.S.A.
Hope, William, 32, Park-lane, Liverpool.
Hunter, John, 17, Richmond-villas, Holloway, N.

Isaac, Frederick Simeon, 28, Queen's-gate-gardens, S.W.
Laycock, William Samuel, Rosemount, Ranmoor, Sheffield.
Lean, Alfred E., 46, Birdhurst-road, Wandsworth, S.W.
Little, Matthew, 18, Thurlow-road, Hampstead, N.W.
Price, Samuel Thomas, 23, Sansome-st., Worcester.
Ross, William, North Wall Ironworks, Dublin.
Sheppard, James, 19, Bennett-park, Blackheath, S.E.
Stanley, William, junr., Great Barrington, Massachusetts, U.S.A.
Stone, Major J. B., J.P., Sutton Coldfield.
Sutton, Thomas, 22, Salthouse-road, Barrow-in-Furness.
Walker, Sydney F., 195, Severn-road, Cardiff.
Waller, Thomas M., Consulate-General of United States of America, 12, St. Helen's-place, E.C.
Yarrow, A. F., Ardmore-house, Blackheath, S.E.

The following candidates were balloted for and duly elected members of the Society.

Barber-Starkey, William Joseph Starkey, Aldenham-park, Bridgnorth, Salop.
Hadfield, Robert Abbott, Hadfield's Steel Foundry Company, Newhall-road, Attercliffe, Sheffield.
Hassall, William, Beach-villa, Meadow-road, Beeston, Notts.
Lewis, Herbert Henry Leech, Cambridge Works, Cambridge-heath-road, E.
Molyneux, Patrick, Atlantic Wharf, Bow common, E.
Stopford, William Henry, 16, Clifton-road, Halifax.

The paper read was—

CAMEO-CUTTING AS AN OCCUPATION.

By John B. Marsh.

The adaptation of the Conch shell to the art of the cameo cutter has no history; it was discovered—as years are reckoned in the progress of art—only yesterday, and to-morrow, if we do not awake to the benefits which the art is capable of realising, the industry may be snatched from our hands. The working of cameos in precious stones goes back beyond the earliest records; history contains no reference to the beginning or the progress of its development. Tradition affirms the Asiatic origin of the art, that it was practised by the Babylonians, from whom the Phœnicians carried it into Egypt. Thence the progress of the art is clearly traced to Greece and Italy, and in our own time to France and England. Those who have practised it in England may be numbered on the fingers of one hand. It is not, however, with the carving of precious stones that this paper is intended to deal, but with the youngest of all the processes discovered in connection with the production of the cameo, that of working the beautiful conch shell.

The use of this shell (specimens of which are on the table) for the purpose of cameo-cutting, was first practised in Italy, about the year 1820, and is believed to be of Sicilian origin. For many years all the shells used were exported from England, and the number averaged about 300 per annum; these were valued at thirty shillings each. They soon became a favourite medium in Rome for workmen, and the art was taken thence to Paris, where it flourished. In 1847 the sale of shells was reported to have reached 100,500, and their declared value was £8,900, while the cameos which were produced were estimated to be worth at least £40,000.

The colour of the ground in these shells varies from pink and orange to an absolute black, which is the most valuable of all. This is called the Black Helmet (*Cassis tuberosa*), and comes from the West Indian seas. The shell, with a pink ground, is called the Queen Conch (*Strombus gigas*), and is also brought from the West Indies. A favourite variety is the Bull's Mouth (*Cassis rufa*), found in the East Indian seas, which has a sard-like ground. Another class is the Horned Helmet (*Cassis cornuta*), which is brought from Madagascar. Occasionally shells are made use of having three layers, the upper, always dark-coloured, serving for the hair, or a wreath, or for armour; the second layer, which is always white, is used for carving the figure; and the third layer is the ground.

When the shells are first taken, they are hung up by the animals which inhabit them; as the poor creatures die, the shell is freed from their hold, and falls to the ground. Were the creature to die in his house, it would greatly deteriorate the value of the shell for cameo work.

Messrs. Francati and Santa Maria, of Hatton-garden, are the largest and almost the only dealers in shells for cameo work the metropolis possesses. This firm, which has branches in Rome, Florence, and other cities of Italy, is famous for its stores of cameos and gems, and for every variety of mosaic work which is produced, as well as for its collection of vases and other art productions of Italy. They are always represented at the exhibitions held; in London, Liverpool, Folkestone, Dublin, and at Edin-

burgh their goods were shown, and they have frequently been awarded medals. I have seen in their cellars many thousands of conch shells, brought from foreign seas for the purpose of being cut into pieces, for export to Italy or Paris. Mr. Santa Maria, upon one occasion, showed me a magnificent Black Helmet shell which he said was the only one that had been discovered out of about ten thousand. A shell of ordinary size only produces, on being sawn, three or four large workable pieces, and these are worth from 3s. to 5s. each; but the Bull Mouth, of small size, may be purchased for a shilling. A face or figure cut upon a whole shell looks well, and one such specimen is here for examination. The experienced workman will often employ his leisure in covering a large shell with work. In the centre is the principal design, always a classic figure or group of figures, and around such ornamentation as his taste approves. One of these, cut in Hatton-garden, was sold recently for a hundred guineas; and another, almost entirely cut by a young Englishman, realised £80.

The most celebrated cameo engraver of modern times was Benedetto Pistrucci, who designed the "George and Dragon" of our coinage, which is acknowledged to be the finest work that has ever appeared in modern currency; and his association with a living worker in cameos, Mr. James Ronca, whom he taught, and the fact that his daughters became accomplished cameo cutters, justify a reference to the leading incidents of his life. Of himself he says that he was in a manner born to the work he took up from choice, and he mentions in proof of this that he had square thumbs, and the palm of his right hand was covered with horny skin. This had been a characteristic with certain of the males in the family for several generations. He was the son of a judge, and was born at Rome, in May, 1784. His eldest brother was a painter, and every member of the family was endowed with artistic tastes. Italy, in his youth, was overrun by the French, which caused his parents to make frequent changes of residence. At fourteen years of age, being then proficient in drawing, he was first put to a master, one Signor Mango, who perceiving his genius, employed him to make designs for his cameos. This provoked much jealousy among the other workmen, one of whom stabbed Benedetto with a dagger. During his illness he amused himself by modelling the figures he drew, and so perfected himself in the stages necessary for becoming an artist in this work; less than this in training will only make a workman. Upon his recovery, he was sent to two masters in succession, the second of whom, noticing the superiority of his designs, exclaimed, "With one who has genius there is very little for a master to teach." At sixteen years of age he began work on his own account; and, after a brief courtship, at eighteen years of age, married a girl of sixteen, of gentle family. He had two daughters, Victoria and Elisa, and one son, Vincenzio. Elisa and her brother were born with the paternal characteristic—a horny palm, and became celebrated as workers in cameo. At twenty-four years of age Benedetto had made a reputation as an engraver of precious stones, having taught himself the process, and constructed with his own hands the wheel with which he worked. For several years he had sold cameos worked in stones to one Angelo Bonelli, a travelling dealer in gems; and discovering one day that a specimen of his work had been stained to represent an antique, and sold for a high price, he resolved for the future to place a secret mark upon those he sold. On one of these, the head of Flora, he cut two Greek letters in the hair. The troubled condition of Italy induced him to consider the advantage of proceeding to England; but, before emigrating, he executed several orders for one of Napoleon's sisters; one portrait being cut in stone, much smaller than a fly. Pistrucci brought to London a letter of introduction to Mr. König, mineralogist of the British Museum, and by Lord Fife was introduced to Sir Joseph Banks. The latter introduced him to Mr. Payne Knight, who produced at the interview what he called the finest Greek cameo in existence, a most choice gem, a fragment of the head of Flora, for which he had paid Bonelli 500 guineas. Pistrucci did not even take the stone from the extended palm of Mr. Knight; a glance disclosed the fact that it was that head of Flora in whose hair he had cut two Greek letters, and for which Bonelli had paid him £5. An unpleasant scene resulted. The letters were plainly visible; but Bonelli, realising that his trade was at an end, boldly denounced Pistrucci. He pointed to the wreath of flowers about the head in proof of his conceit that it was an antique, asserting that no such flowers were then in existence, but Sir Joseph Banks, examining them with a microscope, exclaimed: "The flowers are roses, as I am a botanist." Pistrucci offered to carve another Flora exactly similar without

looking again at the "antique." This challenge was not accepted. Then it was agreed that he should cut a head of Flora in a different position, and this was accepted as a test of his truth. The story soon spread through London society; noblemen, scientific men, ladies of rank, watched the growth of the new Flora under the hands of Pistrucci, and when it was completed the dispute raged with increased bitterness, so that Payne Knight's antique Flora became the question of the day. The controversy at length ended with universal expressions of sympathy for Mr. Payne Knight.

This stone may be seen in the Gold Ornament Room at the British Museum. It is placed in the case of "Modern Engraved Gems," upon which stands the alabaster vase engraved with the name of Xerxes, and is in the bottom row of the case. The face is exquisitely beautiful, and the roses which are cut in the upper coloured layer of the stone are perfect. An attendant will point out this Flora to anyone who asks.

The dispute about the Flora indirectly brought about Pistrucci's appointment to the Mint as chief engraver, and he designed and executed the George and Dragon among other works. Afterwards a considerable amount of jealousy was created by his employment amongst the officers of the Mint, and the members of the Royal Academy were divided about his appointment, one portion insisting that native talent should be encouraged, the other division holding that he was the best living engraver. To restore peace, his appointment was subsequently styled that of "chief medallist." He cut two portraits of the Queen in onyx, one as Princess and the other with the diadem. On retiring from the Mint, he took a cottage at Old Windsor, where he died in his seventy-first year, in 1855, only thirty-one years ago, and recently enough for him to be well remembered by living men. His connection with our own day, and the distinction to which one of his pupils has risen, justify the introduction of his name into this paper. His daughters, before their father's death, returned to Rome, where they practised cameo-cutting with great success.

A brother of Pistrucci—the one who was a painter—followed him to England, and gave lessons in drawing. Amongst his pupils was James Ronca, now one of the best cameo engravers in Europe. After being grounded in the art of drawing, Ronca was put to an Italian named Chelli, to learn the art of cutting cameos, and he had for a fellow apprentice a youth named Ford.

Mr. James Ronca has frequently exhibited gems at the Academy, and he now has the honour of carving the portraits of the Queen and the late Prince Consort for all the Orders of Victoria and Albert which are bestowed by her Majesty. At one time the question of teaching the process at the South Kensington School of Art was discussed by the authorities, and arrangements so far progressed that Mr. Ronca was selected as the teacher; but the scheme was abandoned, owing, as Mr. Ronca believes, to the fact that upon being asked what probability there was for the future employment of skilled workers, he had the candour to say that he did not know of any. This was at a time when the fashion of wearing cameos had almost passed away—and the class was never formed. But the Council of the Society of Arts having had their attention drawn to the subject, a few years ago offered a prize for cameo work, and this was awarded to a young lady who had been taught by Mr. Ronca.

Mr. Ford, after learning to cut under Chelli, went to Rome, and there perfected himself in the work; he was afterwards employed in Paris, and executed some beautiful cameos in England. He is now the head of the firm of Ford and Wright, Clerkenwell-green, diamond polishers; and it was at his stand in the late Colonial and Indian Exhibition that her Majesty, watching the process of washing African gravel for diamonds, picked one out of the soil, and directed that it should be polished for her use. Mr. James Ronca, Mr. Ford, and Mr. Wm. King, in the employ of Messrs. Francati and Santa Maria, are the only three I know who are practically acquainted with the work of cutting cameos.

Mrs. Henry Mackarness, the well-known authoress of "A Trap to Catch a Sunbeam," a lady of acknowledged taste and judgment, strongly recommended the art of cameo-cutting in shell to the notice of ladies. In an admirable work entitled, "The Young Lady's Book," published by Mr. George Routledge, in 1876, she thus speaks of the work:—"It is sufficiently simple to be within the scope of many who possess taste, patience, and deft fingers. . . . . It cannot be acquired without some instruction, and considerable perseverance; but the instruction is within reach, and the perseverance will be amply repaid by the results." This cameo-cutting will "give

young ladies a new and elegant pursuit." It will "raise their thoughts from knitting and netting, and cultivate a taste for higher pursuits. . . . . It can be practised with half-a-dozen small tools that take up scarcely any room; and, with a little care and instruction, the art can be readily acquired. Some knowledge of figure drawing is necessary, and a correct eye; and it is needless to say that the more skilful the artist in this respect, the better her cameo work is likely to be."

There are in the collections shown in the Mediæval room of the British Museum several fine specimens of shell cameos which date from mediæval times, but these shells were found in the Mediterranean; and at South Kensington are a few specimens of shell cameos worked in Rome. The only illustrations of the art of progressive working in the conch shell in any museum in London are to be seen in the south court of South Kensington, where the portrait of Millais is shown in the several stages of progress, together with the shell from which the piece worked was originally cut. This interesting specimen was presented by Mr. Ronca. There are of course many separate specimens of carved conch shells, in whole and in pieces, at both the British and South Kensington Museums.

There were two principal causes for the decline of fashion in the wearing of cameos. The first arose from the paucity of designs, and the second from the bad workmanship engendered by overwhelming orders being thrust upon a market in which only a limited number of operatives were engaged. With regard to the first cause, modern cameo cutters found no other models than those which had been handed down from the times of the ancient workers in gems. The cutters were copyists merely, not true artists, and modern taste was not satisfied with the representation of classic deities, however daintily wrought. There was no variety in the pose of figure, and the minutest detail was settled one or two thousand years before. Thus Apollo, Diana, Jupiter, Mercury, Sappho, and Venus were represented in precisely the same manner they have been a thousand times before, and the cameo worn by a noble lady only differed in the quality of execution from that worn by a greengrocer's daughter.

How the sudden demand for cameos arose it is difficult to say, but orders were poured into Paris houses, and the little colony of Italian and French workers found themselves unexpectedly flooded with wealth. They were men possessed of most skilful hands; but very ignorant, and untutored economists, and they worked hard for a portion of the week only, then shut themselves up in low wine houses, and with cards and dominoes wiled away their time. Their wages were soon exhausted by drink and gambling; and when masters wanted workmen they had first to settle the scores they had run up, for the payment of which the landlords detained them. The natural result soon followed, the quality of work deteriorated, and prices fell considerably; then houses undersold each other, and cameos were cut at per dozen instead of per piece. When the Franco-German war began the cameo occupation was at its lowest point, and the outbreak of hostilities dispersed the major number of workers.

There are only two kinds of tools made use of by workmen, the scawper, and the spit-sticker. The scawper is of two kinds, one having a flat side, and the other a round side. With the round scawper, the white of the shell is scooped out, and the face or design modelled; with the spit-sticker the finer cuts are made; and with the flat scawper the work is smoothed and finished.

When at work, the cutter sits at a bench or table which has what is called a peg or a pin screwed into it. This projects a few inches from the table, and is hollowed to allow of the stick resting within. But an equally good peg is furnished by the fret-cutter's grip, which may be placed at the edge of the table, and, by means of a wooden screw below, fixed tightly in its place. This may be fastened without injury of any kind to the table. One of the advantages which cameo working in shell possesses is, that it occasions no dust or dirt, and does not involve the use of any machinery such as the gem cameo worker requires. If the work is done at night, an engraver's glass is requisite in order to concentrate the light without glare upon the shell. There are two kinds of these glasses; one is filled with water in which sulphate of copper is dissolved, and clarified with oil of vitriol; the other consists of a large green glass eye, which moves up and down an iron rod, and is screwed to the required height. This is the better glass to use, as the oil of vitriol, however much diluted, would, by the accidental breakage of the globe, cause the destruction of any carpet over which it ran. But no glass is required during the day time, and no artificial light is equal to the natural light of day; work should, therefore, be confined to hours before dark.

The first thing to be done is to select a suitable piece of shell for the subject to be cut. Small bits, of the size of the little finger nail, may be bought for 3d.; and oval pieces, from 45 to 48 milimetres in circumference, may be had at from 2s. to 3s. each; and whole shells from 5s. to 20s. each, according to the rarity. In selecting an oval piece, care should be taken to get one without flaw. This is a difficult matter, and requires a great deal of experience. Beginners should select pieces tolerably smooth; but practised workers prefer those which are irregular in their surface, because they furnish more scope for the exercise of their skill. In cutting these, the design follows the convolution of the shell. It is dangerous to lower any one portion, because the white surface does not preserve the same relative thickness all over the piece; and unless care is taken the ground will show through. This is not a disadvantage in the ear, or the neck, but would be serious if it was apparent on the forehead or in the cheek. A skilful cameo cutter will, however, so arrange his design as to produce the blush of the ground in such portions as to enhance the value of his work. Having selected the piece, it is fixed with setters' cement on a stick. The best are made out of a broom handle; cut off five inches, run some cement on the top, and press the ground of the shell into it while warm. The shell adheres firmly, and is now ready to be worked. In drawing the face, avoid, if possible, the rough, rotten looking patches. These are signs of decay which may only be superficial, and disappear at the first cut; but, on the contrary, they are more likely to penetrate deeply, and may necessitate the lowering of the whole face before they can be got rid of altogether. Sometimes when the face has been modelled, and nothing remains but the finishing, a crooked line appears, which cameo cutters believe is caused by the presence of a worm in the early development of the shell. This is very difficult to get rid of, hence extreme care is necessary in selecting the piece for working. A third fault is "flaking," when, by a single cut, the whole of the forehead chips off, or half the nose disappears. There is no remedy then; the whole face must be cut in low relief, or the piece be thrown aside altogether; the latter is often the preferable course. But all these risks are minimised by experience. Having got a satisfactory piece mounted, the stick is held in the left hand, and the face drawn upon it in lead pencil, a little larger than the size actually required. A skilful man will not use a pencil, but cut away at once, and rough out the head and face very quickly. A workman can cut a portrait from a photograph in a few hours; the beginner should not spend more than two hours at a single sitting. Having drawn the face, take up a scawper, and cut the outline almost down to the ground; then separate the hair from the forehead, outline the ear, divide the mouth and nose from the cheek by a single upward cut to the eye-brow; from the corner of the nose cut a triangle—that will form the eye; make two cuts for the nostril and chin, and midway another cut will mark the mouth; sink the neck, outline the collar and coat; then the face is what is technically known as "roughed." At this point it is an interesting study to watch the cameo worker's method. With a scawper in his hand, he makes cuts all over the face, indents the cheek, smooths the ear, fashions the nostrils, lowers the nose, works at the mouth, forms the lips, cuts the chin, rounds the little triangle which contains the eye, marks the arrangement of the hair, with a cut here and there, trims the beard; and so passes over the whole face again and again, bringing every portion into harmony before finishing any one feature. When the triangle has been duly rounded, and the eyebrow formed, a single cut separates the two lids of the eye, and lowers the eye-ball at the same moment. When the eye is open the likeness is complete; a portrait becomes apparent when the nose and mouth are cut, but the fashioning of the eye is necessary to make it perfect. The ear and the hair play important parts in completing the face. To fashion the hair requires a great amount of skill, and the beginner is timid in making his cuts, but he is aided in forming the curved tresses by turning the stick to meet the scawper he is using. A fine scawper is necessary to cut the whiskers and beard, and the cuts should be short and curved. When the whole face has been modelled to the satisfaction of the eye, the third process begins—that of finishing. In this operation the spit-sticker plays an important part. The upper eye-lid is under cut, which adds very much to the appearance of the eye; the hair is also traversed by the spit-sticker as well as the beard, and the tool smooths where it cuts. Finally, a flat graver is used to smooth forehead, cheeks, nose, and chin, taking out all marks of cuts, and softening the appearance of the whole.

In beginning, the learner should cut a few simple outlines, such as are furnished by the

rose, the lily, or the fuchsia; the hand soon becomes accustomed to the use of the tools, and the timid cut becomes exchanged for the vigorous and graceful stroke of the artist. When progress has been made so far as to justify the cutting of a face, the learner should begin with separate features—the ear, the mouth, the nose, or eye; the hair will require a considerable amount of practice, but by perseverance all difficulties vanish, and when the features can be cut to the satisfaction of the teacher, then a whole face should be tried where no likeness is necessary. To produce a portrait, take a tracing and draw a star across it, then transfer the face to a star upon the shell. Make free use of a pair of compasses. The variations of eye, nose, mouth, and hair are quickly caught, and the likeness is complete. A portrait is not obtained by a series of bold sweeping cuts, but rather by a multitude of light touches, in which the surface is gradually shaved into the requisite form.

Great care is necessary in working the shell so as not to cut into the ground, on account of the extreme difficulty of removing any mark. When the work is finished, the first thing to do is to remove all marks from the ground. This is effected by the use of powdered pumice stone and water, applied on a piece of pointed wood; the next process is to smooth the surface with pumice stone and oil; wash with a soft brush and warm water, then polish with the dust of the rotten stone and sulphuric acid mixed to a paste, and applied on the point of a piece of wood.

With respect to the articles required for commencing work, the following list embraces all that are necessary:—Four round-sided, and one flat scawper, one spit-sticker, one file; seven tools, 1s. 9d.; one fret-worker's grip, 1s.; a dozen pieces of shell of various sizes, 5s.; one broom handle, 2d.; cake of cement, 1d.; one oilstone, 5s.; total, 13s. With such an outlay one can begin work at once. All those articles may be purchased at the shop of Messrs. Gray and Son, dealers in jewellers' materials, Clerkenwell-green; or at the shop of Mr. G. Schultz, cutler, 27, Sloane-square, Chelsea, S.W. If the cost of these tools is compared with the expenditure necessary on many occupations to which ladies and gentlemen devote their talents in spare hours, it will be admitted that cameo-cutting carries the palm for cheapness. When it is further considered that this may be resorted to for an hour, at any time, and does not involve the use of any machinery for its pursuit; nor the exclusive possession of any special table; while it is absolutely free from dirt or dust injurious to furniture, to the carpet, or to the dress; that it is not trying to the sight; and not attended with risk to the hands, it must be apparent that in cameo-cutting an occupation is presented which has undoubted claims to consideration. All who engage in it become fascinated by the results which are obtained. Children of tender years quickly become absorbed in the work, which not only trains the eye and the hand, but elevates and corrects the taste. To what more pleasant use could a child put the knowledge of drawing which it has gained at school. But it is not solely as an occupation for children that cameo-cutting should be considered. Between the simple forms which a child may cut, and the classic groups of finished *artistes* such as abound, there is scope for the exercise of every degree of talent. There are *artistes* in cameo now in Rome and Paris whose touches are readily identified whatever they treat, in the same way that the touches of a first-class sculptor are recognised. This Society has already revived in England the practice of wood carving; is not that of cameo-cutting a kindred pursuit equally deserving of cultivation? Wood-carving is an ancient industry revived; cameo cutting is an entirely fresh one, and its practice would add a new source of enjoyment and of wealth. French taste, German industry, Italian art, meet us in the markets of the world, and strive for complete ascendency, to the exclusion of British productions; but with an improved education, a more elevated taste, and indomitable industry, we may become formidable rivals even in departments from which we have hitherto been thrust out. As a very unassuming worker of cameos, I desire to recommend the art to your consideration.

DISCUSSION.

The Chairman, in inviting discussion, said they must all feel the obligation they were under to Mr. Marsh, for bringing forward in so clear a manner the details of a new occupation, which seemed specially suitable for ladies to pursue. He could not help feeling how difficult it was to discuss a paper written by one who proved himself to be a master of the subject, but he was sure that, if anyone had any questions to ask, Mr. Marsh would be most happy to give any further information in his power.

Mr. P. L. Simmonds said this subject was one of great interest to him, and he remembered it being

brought before the Society by the late Dr. Gray, and he himself had advocated cameo-cutting as an occupation on several occasions. Some thirty years ago, in a lecture at Newington, he entered in some detail into the matter; and at South Kensington, on one occasion when he had to take the place of Dr. Gray, in lecturing on the industrial uses and economical application of shells, he again took up cameo-cutting. He had also alluded to it in a paper in the *Journal*, dealing with cameo-cutting on precious stones, and later still he had dealt with it in a work on the commercial products of the sea. He had had many opportunities at different exhibitions of noticing specimens of cameo-cutting, especially in the Italian and French courts, and very much regretted to see that it had so much declined in this country, and that the use of cameos had very much gone out. Whether this was due to the reason mentioned by the reader of the paper, or whether it was simply the fluctuation of fashion, he did not know, but he thought much more might be done to develop the art. The information given in this paper was much more practical and detailed than he had seen before, and the only point on which he could criticise it was in respect to the name given to the shells. In commerce the term conch was mainly applied to the queen conch, which was not much used in cameo-cutting, because it had only one layer, the black helmet and the bull's mouth being much more commonly employed. It was very desirable that these shells should be more used for cameo-cutting, instead of being merely ground up for lime. He had been somewhat criticised before now for advocating the utilisation of many of these natural products, such as shells, feathers, skins, and other objects, but he thought they could not develop too much the industrial and economical uses of these articles. The conchologist might blame them for cutting up these shells, but in his opinion if they could throw an occupation into the hands of the people, and improve their skill and artistic development, a great deal of good would be done. That Society had certainly led the way in the development of many industries during a long period, and if it could do anything in connection with cameo-cutting it would be only following out the path which it had continuously pursued.

Mr. Owen Roberts said Mr. Marsh had referred to an attempt made some time ago, at South Kensington, to establish classes for cameo-cutting, but he believed that was an error, and that he recognised in the allusion an attempt made at the South Kennington School of Art, which was connected with the City and Guilds Institute, of which he was then honorary secretary. That school was then under the superintendence of Mr. Sparkes, who drew his attention to this matter, and they endeavoured to establish such a class. The Guilds were quite willing to undertake the expenses attending upon it, and Mr. Ronca was the gentleman selected for teacher, but although the class was announced in the programme from time to time, Mr. Sparkes told him they found it impossible to start it. He was very glad to find that Mr. Marsh had brought it up again, and he could assure him, on the part of the City and Guilds Institute, that if he could put them in the way of establishing a class at the South Kennington School of Art, there would be no difficulty in carrying it on. The Guilds Institute had over and over again expressed its desire to revive any industries of an artistic character which had been, from any cause, in abeyance, or to establish new ones, and if Mr. Marsh would put himself in communication with the organising director, he could assure him he would find every disposition to help in his scheme.

The Chairman said they must all be glad to hear what had been said by Mr. Roberts, who, from his connection with the City and Guilds Institute, spoke with authority, but unless they could find pupils as well as masters, he feared the result would be the same as before. The great object should be to find pupils, but there ought to be abundance of such, and he was sure that Mr. Roberts, who was well-known for the energy he had shown in the establishment of classes for female labour and the higher education of women, would devote his best efforts to the forwarding of such an object.

Miss Webster asked if there were any workmen in London who were prepared to execute portraits in a similar style to the specimens shown at a moderate price. If so, it might open a new field, for there was often a difficulty in knowing what to send to friends in the country or abroad. Portraits executed in this manner would be very acceptable, and much more lasting than photographs or crayon, or water-colour drawings. She had frequently heard that cameos had gone out of fashion because they were considered ungainly, and sometimes hideous, but it occurred to her that medallions might be applied to furniture in the same way as Wedgwood plaques.

Mr. J. W. Marsh said, in reply to Miss Webster's question, that he thought it was in portraiture that those who took up this art would mainly succeed. You could not at present go into any shop or warehouse in London and get a portrait cut upon a cameo without the photograph being sent to Paris or Rome. But the few specimens on the table would show that it was quite possible for any one with a fair artistic ability, and a little training of the hand, to acquire the power of cutting portraits successfully. With regard to the use of the cameo when cut, it was eminently adapted for the ornamentation of furniture in the way suggested, but the ornamentation need not be confined to portraits; flowers, groups of figures, and other designs suitable to such purposes were innumerable. He might mention that there was present a young Englishman

who would be prepared to give instruction in this art, and he was the only one in London who could cut portraits. It was a curious fact that until he went to him about a twelvemonth ago, and asked him for a little help out of a difficulty in cutting a face, he had never attempted to cut a portrait, but he could now do it with a facility and finish equal to any artist in Rome. He was pleased to hear Mr. Simmonds suggest that some better use should be found for these beautiful shells than grinding them up for lime. He should have much pleasure in communicating with the City and Guilds Institute, as Mr. Roberts suggested, and pointing out to them that the services of a teacher could be secured. Of course, before a teacher was engaged, pupils must be found; but he thought, with the publicity given to the matter in the *Journal*, pupils would be making inquiries, and by communicating with the City and Guilds Institute, pupils and teacher might be brought together. Having drawn attention to the specimens of shells sent by Mr. Santa Maria, he thought it best to use the name commonly applied to them, the conch, rather than the Latin names for the different varieties, but these would be found in the printed paper. He had had innumerable applications to cut portraits, but as he only practised the art as an amusement, he could not go into it as a business. He had not the smallest doubt, however, that in portraiture there was a large and remunerative field to those who would acquire the art. Mr. Marsh then read a letter from Mr. Thomas Fowke, who wrote :—"I have followed the profession of cameo-cutting for the last fifty years, and at one time had a very good practice as a portrait cutter, but for the last ten years the profession in this country has become almost, indeed I may say quite, extinct. .... If you can by any means do anything to revive the art I for one shall be glad."

The CHAIRMAN, in proposing a vote of thanks to Mr. Marsh, said that if, with the assistance of the Society and the City and Guilds Institute, the art of cameo-cutting were fostered, this would be another added to the many useful industries which had emanated from that room.

The vote of thanks having been carried unanimously, the meeting adjourned.

Miscellaneous.

VEGETABLE PRODUCTS OF EAST AFRICA.

Scarcely a tribe in Eastern Africa but grows some kind of cereal, searches for some sort of edible tuber, or utilises one or more varieties of wild fruit.

On Zanzibar island, the red loamy soil produces durra (*mtama*), maize (*mahindi*), sweet cassava (*mhogo*), a species of pea growing on a tall bush (called *mbalzi*), coconut palms, bananas, mangoes, oranges, lemons, custard-apples, and other fruits. The coconut palms are chiefly utilised for the preparation of a palm-wine (*tembo*). In Unyamwezi, the people cultivate rice, sorghum (*mtama*), small millet, sweet potatoes, yams, ground-nuts, beans of all sorts, tomatoes, citrons, and bananas in abundance. The favourite beverage is millet beer (*pombé*).

At Konduchi, maize and millet grow well. Dar-es-Salaam has plantations of rice, coconut palms, maize, and sweet cassava. At present plantains and maize are the staple articles cultivated and consumed by the Wasambara; excellent ginger grows wild, and is also cultivated by the natives for their own use. In Magila occur plots of bananas, sweet cassava, and rice; tamarinds (*mkwaju*), and doum palms or *mlala* (*Hyphœne thebaica*) grow wild.

The common vegetable products of Usambara are rice, sweet cassava, maize, and sugar-cane. Oil-palm trees or *mchikichi* (*Elœis guineensis*) are to be found at intervals. The coconut palm seems to cease with the first outlying range of mountains, or as soon as the sea breeze is shut off; but beyond that, the banana becomes very abundant, and its unripe fruit, boiled and threaded on the twigs of bushes to dry in the sun, forms the staple food of the highlanders. Thus prepared, the banana acquires a flavour very like that of the potato. On the Rufigi, in times of scarcity, the people eat roots, and the heart of a kind of palmetto (locally called *milala*) which tastes much like the heart of the coconut palm. The Mawanda, besides fish, dig up a white tuber, about the size of a potato, in the forest; this they cut into thin slices, and soak in the river for a day, afterwards thoroughly drying it in the sun, pounding and boiling, or making it into flour. The beer made from it is said to be very good and strong The Marongwe people possess coconut palms, sugar-cane, and bananas, and distil an ardent spirit in stills of native manufacture.

In the Shishongi country, Southern Mozambique, grows a cherry-like fruit, known to the natives under the name of *simwerbi*, furnishing a delicious and refreshing feast. Its juice is, however, so heavily laden with indiarubber, that the moustache gets varnished, and the lips almost cemented together, when the fruit is eaten; the berry is, nevertheless, one of the most palatable fruits of the country, with a lusciously sweet taste and milky juice. It has a few light brown enamelled seeds, and grows in luxuriant abundance upon a large evergreen tree Elephants appreciate this fruit quite as highly as men. The natives look upon the trees in the light of a granary during a couple of months or so, when they are golden with their crop. The fruit is at its best in the middle of January, and at that season it is made into a very pleasant wine, decidedly the best drink prepared by the natives, who also produce fermented beverages from the *imbongwa*, the *mayogomela*, the waterboom, the *um'shungowa*, and a species of palm

all wild and uncultivated bush growths. The *imbongwa* is the rubber plant of the country. It bears an edible fruit, which yields the juice that is fermented into wine; the fruit is about the size of an orange, with a yellow skin or shell, easily broken by the thumb-nail. It contains a number of flattish seeds, which are imbedded in a small quantity of acid pulp, saturated with sweet juice. The seeds and pulp are squeezed out and watered, and then put in the sun to mature. The plant is a climber, with a light brown rough, lumpy bark, and a stem occasionally as thick as a man's arm. The rubber furnished by it is of the kind known as "fingers."

The *makwaka*, a very highly-prized Tonga food luxury, is prepared from the large calabash-like fruit of a deciduous shrub, greatly appreciated by elephants. The calabash is full of a bright orange-coloured seed, about as large as a shilling when ripe, and at that time covered with a thick glutinous coat. The seeds are dried upon a wickerwork frame, fixed over a hole, with a fire kindled at the bottom. The seeds acquire a flavour from the smoke, and assume a dark-brown colour. The roasted seed-coat or testa is then stripped off the seed by the women, pounded in wooden mortars, and pressed into drums made from *umtonto* bark. In that stage it is very like oat-cake, and when mixed with honey is palatable, notwithstanding its pervading bitter taste. There is a refined way of preparing it green, when it is called *shugutsu*, and is deservedly in high estimation. In this form of preparation, the seeds are soaked in a succession of quantities of water, to extract their bitter flavour before they are stamped. In this state, however, the product is so rich and rare that it is not to be bought. A dark-coloured oil drops from the drums of matured *makwaka* in considerable quantity, and has proved to be a good lubricant.

That part of southern Mozambique occupied by the Hlenga tribe, produces a kind of vine called *umtshangowa*, whose flowers are most fragrant, while the edible fruit is made into blood-red wine by the natives. In the Sabi river valley occurs a notable palm, the *umfuma* or *umkowan*, which grows to a height of 100 feet, is thicker in the middle than above or below, and has a fruit somewhat like the coconut in appearance, but consisting of three large seeds in a husk, which are eaten after they have been made to sprout.

The cultivation between Dar-es-Salaam and the Kingani River embraces maize, cassava, millet, peas, mangoes, and bananas; wild "cherry" trees (*kunazi*) occur. At Akeda Ferhan, sugar-cane, millet, maize, cassava, peas, melons, pumpkins, saffron, castor oil plant, papaw, tamarinds, and cotton are cultivated; also tomatoes (*nyaya*). In the Shiré country, when provisions are scarce, use is made of wild herbs, mushrooms, and *masuku*, the last-named being a fruit resembling a pear, with russet rind, and three large grooved stones inside, which falls immediately it is ripe. A noticeable feature in Makualand is the very extensive cultivation of the cashew tree, from whose fruit is distilled a very strong spirit called *arripa*.

On the shores of Lake Nyassa, several wild fruits are eaten. One is a yellowish-green ball, about as large as a Tangerine orange, with a raw tasting pulp like a medlar, and called *malembe*. Another is the *ntuza*, a green plum with several stones; it is uncommonly good, and would make a fine fruit if cultivated; it is sometimes dark purple, like damascenes. A tree bearing an edible fruit called *maula*, resembling a small rennet, with a sweetish taste but a large stone in the middle, grows on the western and northern sides of the lake. Here they make *moa* beer, from a mixture of cassava and small millet; it seems to be inferior to *pombé*. Cassava meal, eaten after grinding and drying, is known as *ufa*. There is one peculiarity about cassava that commends it to those tribes who are in danger of attack from their neighbours, which is that the crop never matures all at once, so that while some tubers are fit for use many others are not worth seeking, and offer no temptation to plunder. Cereals, on the other hand, ripen at a certain season, and the whole crop may be carried off at once, leaving the growers in a state of starvation.

A traveller in the Mukondokwa valley, near the Zanzibar coast, mentions *Amaranthus melancholicus* as making a good salad, and "forming trees similar to the copper beech;" a statement that needs some elucidation.

PARIS JUBILEE OF RAILWAYS.

On Tuesday, 18th inst., a public meeting was held, at the invitation of M. Alfred Louis, Commissioner-General, for the purpose of hearing a detailed explanation of the arrangements in contemplation for obtaining the most beneficial results from the proposed International Exhibition and Congress to be held this year in Paris. Mr. E. Woods, President of the Institution of Civil Engineers, occupied the chair. Captain Douglas Galton, C.B., Chairman of the Council of the Society of Arts, was present. After remarks from members of the Paris Municipality, the following resolution, proposed by the Chairman, and seconded by Sir John Fowler, was carried:—

"That this meeting, having heard the statements made by the Commissioner-General and the other speakers, expresses the sympathy of the gentlemen present with the objects of the jubilee of railways, and think it desirable that a proper response should be made from England to the invitation received from Paris to take part in the celebration."

The following gentlemen were appointed a committee to co-operate with the French Executive:— Mr. E. Woods, Sir J. Fowler, Sir C. H. Gregory, Sir J. Bazalgette, and Mr. Crampton, with power to add to their number representatives of railway com-

panies and members of the City Corporation and scientific bodies.

The Exhibition is to be held from May to November next, in Paris. The classification consists of eight groups. Group 1.—History of railways, instruments, architecture. Group 2.—Railway construction, including earthworks, tunnelling, bridges, viaducts, permanent way, ballasting, sleepers, &c. Group 3.—Terminal and other stations. Group 4.—Rolling stock. Group 5.—General working of railways. Group 6.—Application of electricity to railways. Group 7.—Publications. Group 8.—Agriculture.

Correspondence.

LIEBIG'S WORKS.

Some time ago, during an interview with Professor von Voit, of Munich, I had the honour of submitting to him a copy of my Cantor lectures, "On the Discoveries and Philosophy of Liebig," with the view of obtaining from him some information regarding the list of publications of Baron Liebig, which, in chronological order, is attached to the end of the lectures. Professor von Voit did me the favour of comparing my list with the list of Liebig's writings which is contained in what is termed the "Almanack" of the Munich Academy of Sciences, of which Liebig was President. It appears that Liebig began to register his writings (in this Almanack) only in 1847. The following, found in the Almanack, but not contained in my list, should be added thereto:—1847 and 1848, in the *Annalen*; "On Endosmosis and the Circulation of Juices with Animal Organism;" "On Fermentation and Putrefaction;" "On the Amount of Carbonic Acid in the Blood;" "A Reagent for Prussic (hydrocyanic) Acid;" 1849, "Composition of the Ash of some Plants;" 1851, "On the Proximate Constituents of the Animal Body;" "Estimation of Phosphoric Acid in Urine;" 1853, "Analysis of the Mineral Water of Mergentheim;" "A Guide to the Analysis of Organic Compounds," Brunswick; 1856, "On Theory and Practice in Agriculture," *Ibid*; 1858, "The Fundamental Truths of Agricultural Chemistry," *Ibid*; 1859, "Letters of a Natural Philosopher on Modern Agriculture," Leipzig. Further some minor notes contained in his collected "Orations and Essays."

Professor von Voit believes that with these additions my list is nearly complete, and is very useful to those who desire to find and consult these writings. Professor von Voit has also directed my attention to an error in which I have fallen in ascribing to Bischoff and Edward Smith the discovery, that muscular exercise did not increase the waste of albuminous matter. This discovery belongs indisputably to Professor von Voit, has never been claimed by Bischoff, who had not the smallest share in it, and the relative experiments of Edward Smith were made several years after those of Voit, and, in addition, were not in themselves conclusive.

I hope that these corrections will not only appear in the *Journal*, but be added as a supplement to the reprint of the lectures.

T. L. W. THUDICHUM, M.D.

THE TUSSUR SILKWORM AND ITS HYBRIDS.

Though I refrained from commenting on the letter of one who is so great an authority on sericulture as Mr. S. Cunliffe Lister, the communication from Mr. T. F. Peppé (in the *Journal* of January 7th) emboldens me to try to carry the discussion one step further. This I propose to do in respect of two points—(1) Mr. Lister's virtual exclusion of other silk culture in India, except that dependent on the mulberry tree; (2) accepting Mr. Peppé's estimate of the value of tussur silk and the facilities for its production, I venture to urge that a much superior quality of silk may be obtained from a hybrid, but fertile worm, which can be fed and its cocoons gathered as easily as Mr. Peppé shows, can be done in the case of the tussur.

To take the latter point first, let me ask those really interested in the subject to refer back to my communication in the *Journal*, No. 1,528, March 3rd, 1882; also to the note on p. 349 of the same volume, (xxx.) there will be found description of the hybrid worm produced by cross between the tussur and the *Yama-maï*, or oak-feeding moth of Japan. As there stated, the cross proved fertile, and can be reproduced to any extent. Not only is the silk produced by this hybrid much finer than that from the tussur, but it is nearly free from the mucilaginous matter that makes the reeling of the tussur cocoons so troublesome. The great advantage of this improved silkworm from the producer's standpoint, and as compared with the *Bombyx mori*, is that the *Yama-paphia Mowisia* (to use my provisional name for the hybrid) will feed not only on the trees and plants which suit the tussur, as described by Mr. Peppé, but on almost every variety of the *ficus*, which is, perhaps, the most widely diffused of all Indian trees. The variety most accessible and suitable in Western India is the bhair tree (*Zizyphus jujuba*), with which no doubt Mr. Peppé is well acquainted. The special value of his giving attention to the subject is, as I can see from his letter, that he would be able to instruct not only the "jungle-wallas" but settled villagers in the very simple methods required for breeding the hybrid worms and collecting the cocoons, if not also reeling the silk. Such an industrial exploitation as this concerns the lower, but also wider, side of the Indian economic problem;

and if Mr. Peppé can popularise this simple but very productive form of sericulture, he will confer a very great benefit on the struggling rural population. It is much to be regretted that the "Agricultural Directors" of India allowed the opportunity to pass by, when it was offered some seven years ago, of carrying out the cultivation of this valuable new silk-worm. But the industry could be easily started afresh by procuring the grain of the *Yama-maï* from Japan; and if fortunate enough to meet with as patient and persevering an experimenter as Mr. Paul Mowis, the fertile hybrid could be again produced.

With regard to Mr. Lister's view that the silk production of India must be dependent on the mulberry tree, that I have already answered by implication. Let the mulberry silk be cultivated, and the filatures be improved by all means; but there are large tracts of India where the mulberry will not thrive, and where the *Bombyx mori* is of no use whatever. So far as Western India is concerned, the Honourable Company demonstrated this proposition sixty years ago, by the expensive experiments of a skilled Italian, who was sent out for the purpose. Thanks to the extended knowledge of Indian botany and entomology, as applied with so much discretion by Mr. Wardle and his predecessors, it is now seen there is a far wider field for Indian sericulture than that prescribed by the growth of the mulberry tree. It is the wider field that most needs cultivation.

W. Martin Wood.

West Kensington,
Jan. 19th.

Notes on Books.

Ornamental Turning. By J. H. Evans. London: Published by the Author.

Mr. Evans, whose paper on "The Modern Lathe," published in the *Journal* for February 9, 1883 (vol. xxxi., p. 256), will be remembered by the members of the Society who are interested in the subject, has added another to the already numerous books on Turning. In doing this, he has carefully confined himself to one portion of his subject, the subject indicated in his title, in the most limited sense of the term, since he excludes that branch of ornamental turning more strictly described as geometrical turning, the decoration, namely, of flat surfaces with intricate interlaced patterns of incised curved lines. Nor does he deal with the history or construction of the lathe itself. He assumes a knowledge of the art of simple turnery, and proceeds to show the workman how he may decorate with solid ornament the forms produced, or he may modify these simple forms into the many curious and complex shapes which, to all but an expert, the latter would seem incapable of originating. Chapter one describes a modern ornamental lathe, with traversing mandrel, ornamental slide-rest, division plate, overhead motion, &c. The second chapter deals with chucks and methods of chucking. Several chapters follow, dealing with the details of the lathe, methods of grinding and setting tools, including full description of the goniostat and instructions for its use, materials and their treatment, &c. Chapters on the slide-rest and the overhead motion lead on to descriptions of tools and cutters, the special implements by which so large a share of the ornamental work is done, while the object to be ornamented is itself held motionless in the lathe. The eccentric, ellipse, spherical, and other chucks, then come under consideration, and finally, the various complicated pieces of mechanism with which the most elaborate and costly lathes are now fitted.

The various pieces of apparatus throughout are not only described, but actual directions for their construction are given, for the benefit of that small, but skilful, class of amateurs who prefer to make their own tools. Numerous examples, printed in collotype from photographs of the originals, are given, to show the precise nature of the work of which each apparatus is capable.

Obituary.

Sir Francis Bolton.—Colonel Sir Francis Bolton died on Wednesday evening, 5th inst., at the Royal Bath Hotel, Bournemouth, where he had been staying with Lady Bolton for the past two months. Sir Francis John Bolton was the son of Dr. T. W. Bolton, and was born in 1831. He entered the army at the age of twenty-six, and after three years' active service, for which he received special thanks, was promoted to a Captaincy in the 12th Foot. From 1866 to 1869 he was attached to the Royal Engineers, and at the close of that period obtained his promotion as Major (unattached) in consideration of special military scientific services. He was the inventor of the system of telegraphy and visual signalling adopted in her Majesty's services in 1863. In 1877 he became Lieut.-Colonel, retiring as Colonel in 1881, and in 1884 the Queen conferred upon him the honour of Knighthood. The services rendered by Sir Francis in connection with the South Kensington Exhibitions often engaged his presence and attention up to a late hour of the night. The arrangements for illuminating the fountains by means of the electric light were due to his ingenuity, and received his personal superintendence, in addition to which he aided in organising the system of electric lighting, which formed so attractive a feature of the Exhibitions. Sir Francis Bolton was appointed Water Examiner under the

Metropolis Water Act in 1871, and in the same year he was elected a member of the Society of Arts. He was a Vice-President and Honorary Secretary of the Society of Telegraph Engineers and Electricians, of which Society he was one of the founders. The first symptom of his illness was a failure of his voice, for which he visited Brighton; while there, an abscess developed itself in his throat. This, however, appeared to yield to treatment, and was supposed to be cured by the time he removed to Bournemouth.

General Notes.

BRUSSELS EXHIBITION, 1888.—A Commission has been appointed to organise a "Grand Concours International des Sciences et de l'Industrie," to be held at Brussels in 1888, and a plan of classification and regulations have been printed. The galleries of the *Concours International* will consist of a series of special exhibitions, each of which will be devoted to objects of the same class. There will also be an Exhibition of Importation and Exportation, divided into five sections and fifteen groups. Conferences will be held in connection with the *Concours*.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

JANUARY 26.—"Photographic Lenses." By J. TRAILL TAYLOR. JAMES GLAISHER, F.R.S., President of the Photographic Society, will preside.

FEBRUARY 2.—"Sewage Irrigation." By ALFRED CARPENTER, M.D. Captain DOUGLAS GALTON, D.C.L., C.B., F.R.S., Chairman of Council, will preside.

FEBRUARY 9.—"Purity of Beer." By A. GORDON SALAMON.

FEBRUARY 16.—"Uses, Objects, and Methods of Technical Education in Elementary Schools." By HENRY H. CUNYNGHAME.

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

NOTE.—The paper of Mr. Reckenzaun, on "Electric Locomotion," announced for February 2nd, has been unavoidably postponed. It will be read later in the Session, and due notice of the reading will be announced.

DATES TO BE HEREAFTER ANNOUNCED.

"Miners' Safety Lamps." By EDWARD H. LIVEING

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Irish Industries." By REV. CANON BAGOT.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

"Railway Brakes." By WILLIAM P. MARSHALL.

"The Living Organisms of the Air: the Effect of Place and Climate on their prevalence." By DR. PERCY FRANKLAND.

"The Cultivation of Tobacco in England." By E. J. BEALE.

"Electric Locomotion." By A. RECKENZAUN.

INDIAN SECTION.

Friday evenings, at Eight o'clock :—

FEBRUARY 11.—"The Economical Condition of India." By DR. WATT, C.I.E.

MARCH 4.—"Our Trade Routes to the East." By MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B.

MARCH 25.—

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

MAY 27.—

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 25.—"Volcanic Eruption in New Zealand." By KERRY NICHOLLS. SIR FRANCIS DILLON BELL, K.C.M.G., C.B., will preside.

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

The dates for the following Papers are not yet fixed :—

"Fiji." By JAMES MASON, C.M.G.

"The West Indies." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

"Australian Wines." By RICHARD BANNISTER.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

FEBRUARY 1.—Opening Address on "The Condition of Applied Art in England, and the Education of the Art Workman." By T. ARMSTRONG, Director of the Art Division, Science and Art Department. SIR GEORGE BIRDWOOD, M.D., LL.D., C.S.I., will preside.

FEBRUARY 22.—"Wrought Ironwork." By J. STARKIE GARDNER, F.G.S.

MARCH 15.—"The Application of Gems to the Art of the Goldsmith." By ALFRED PHILLIPS.

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

CANTOR LECTURES.

The Second Course will be on the "Diseases of Plants, with special reference to Agriculture and Forestry." By T. L. W. THUDICHUM, M.D. Three Lectures.

LECTURE I.—JANUARY 24.—Introduction.—Comparison of animal and vegetable pathology.—Definition of principal disease causes as living parasites.—Fungi.—Bacteria.—Bacilli.—Sarcinæ.—Zooglœa.—Micrococci.—Description of potato disease as illustrating the combined action of Endophytes and Saprophytes.—Survey of parasitic Fungi.—National economy and politics as affected by epidemic diseases of plants.

LECTURE II.—JANUARY 31.—Epiphytes or Fungi living upon, as distinguished from Endophytes or Fungi living within, the tissue of other plants.—Parallelism with Epizoa and Entozoa.—Description of the diseases caused by Fumago or foot-dew.—Mildews—their effects upon gardens, cultivated fields, and forests.—Fungi as medicines.

LECTURE III.—FEBRUARY 7.—Animal parasites as causes of epidemic plant diseases, illustrated by the Phylloxera.—Comparison with Oïdium.—Aphides or green-fly.—Survey of parasites on forest trees.—Necessity of greater attention to forest culture as a science.—Physical and chemical causes and effects of diseases of plants.—Comparison with vegetable ferments, beneficial and hurtful.—Diseases of wine and beer.—Conclusion.

The Third Course will be on "Building Materials." By W. Y. DENT, F.C.S., F.I.C. Four Lectures.

February 14, 21, 28; March 7.

The Fourth Course will be on "Testing Materials of Construction, especially Iron and Steel." By Prof. W. C. UNWIN, F.R.S. Three Lectures.

March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Structure of Textile Fibres." By Dr. FREDERICK H. BOWMAN, F.L.S., F.G.S. Five Lectures.

April 25; May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. L. W. Thudichum, "The Diseases of Plants, with special regard to Agriculture and Forestry."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

London Institution, Finsbury circus, E.C., 5 p.m. Mr. H. H. Statham, "Ancient Buildings and the 'Restoration Question.'"

TUESDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. J. H. Kerry Nicholls, "The Volcanic Eruption in New Zealand."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. William Joseph Dibdin, "Sewage-Sludge and its Disposal." 2. Mr. William Santo Crimp, "Filter-Presses for the Treatment of Sewage-Sludge."

Anthropological, 3, Hanover-square, W., 8 p.m. Annual Meeting.

East India Association, Westminster-palace-hotel, S.W., 3 p.m. Sir George Campbell, "The Capital of India."

Cymmrodorion Society, Lonsdale-chambers, 27, Chancery-lane, W.C., 7½ p.m. Mr. J. P. Seddon, "Early British Architecture" (with illustrations).

WEDNESDAY, JAN. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Traill Taylor, "Photographic Lenses."

Geological, Burlington-house, 8 p.m. 1. Mr. Thomas Roberts, "The Correlation of the Upper Jurassic Rocks of the Jura with those of England." 2. Rev. A. Irving, "The Physical History of the Bagshot Beds of the London Basin."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

THURSDAY, JAN. 27...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. A. Barrett, "The Comic Songs of England." (Lecture I.)

Royal Institution, Albemarle street, W., 3 p.m. Prof. A. W. Rücker, "Molecular Forces." (Lecture II.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Prof. S. P. Thompson, "Telephonic Investigations."

Society for Preserving the Memorials of the Dead, 17, Oxford-mansions, Regent-circus, W., 4 p.m. 1. Mr. W. J. Loftie, "Epitaphs." 2. Mrs. Danvers Taylor, "Stanley-le-Hope Church, Essex," Fetherston Monuments (illustrated). 3. Mrs. Danvers Taylor, "Downham Church, Essex," Tyrell Monuments (illustrated). 4. Exhibition of Drawings of the Ancient Sepulchral Monuments of Essex.

FRIDAY, JAN. 28...United Service Institnte, Whitehall-yard, 3 p.m. Lieutenant W. C. H. Snell, R.N., "A few remarks on Naval Strategy, with the outline of a game for its study in time of peace," to be read by Captain P. H. Colomb, R.N.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. W. Baldwin Spencer, "The Pineal Eye in Lizards."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Mr. J. T. Nettleship, "Browning's Treatment of Landscape."

SATURDAY, JAN. 29...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "Modern Composers of Classical Song—Robert Franz" (with Vocal Illustrations). (Lecture II.)

From the Proceedings of the Royal Geographical Society 1884.

E. Weller lith. Red Lion Square.

Journal of the Society of Arts.

No. 1,784. Vol. XXXV.

FRIDAY, JANUARY 28, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

The following circular, with a copy of the letter of H.R.H. the Prince of Wales, which appeared in the number of the *Journal* for January 14th, is being issued to the members of the Society. The Council will be glad if members who are willing to undertake the collection of subscriptions will communicate at once with the Secretary:—

January, 1887.

Sir,—We are instructed by the Council to send you the accompanying letter, which has been addressed to their Chairman by H.R.H. the Prince of Wales, the President of the Society, and to express the hope that the members of the Society generally will co-operate with the Council in carrying into effect the important proposals which have been put forward by his Royal Highness.

It is believed that members of this Society may assist the movement for the foundation of the Imperial Institute in two ways—

1st, by personal subscriptions;

2nd, by undertaking to collect contributions.

The Council are assured that all classes of the Queen's subjects will be glad to have an opportunity of taking part in this national memorial of Her Majesty's eventful reign, and they feel certain that the memorial will have a greatly enhanced value if it comes to the Queen as the gift of all classes of her people.

They are anxious that the Society of Arts should take a leading part in the establishment of an Institution which will not only serve as an expression of the respect and affection with which our beloved Queen is regarded throughout her great Empire, but will also assist in promoting the objects for which the Society has laboured for more than a hundred and thirty years.

The Council will gladly take charge of any contributions you may send, and they will also be gratified to learn that they may forward you a form for the collection of donations.

It is specially hoped that those members of the Society who are employers will assist the movement by collecting subscriptions from the persons in their employment.

Subscriptions of the very smallest amount will be cordially welcomed.

Lists of members subscribing or collecting, with the amount subscribed or collected, will be published from time to time in the *Times* newspaper, as well as in the *Journal of the Society of Arts*.

Forms to facilitate your reply are enclosed.

We have the honour to be, Sir,

Your obedient servants,

Douglas Galton,
Chairman of the Council.

H. Trueman Wood,
Secretary to the Society.

CANTOR LECTURES.

On Monday evening, 24th inst., Dr. Thudichum delivered the first lecture of his course on the "Diseases of Plants, with special reference to Agriculture and Forestry," in which he defined the chief causes of disease. The lectures will be printed in the *Journal* during the summer recess.

SECTION OF APPLIED ART.

The opening meeting of this Section will be held on Tuesday next, February 1, when Mr. T. Armstrong, Director of the Art Division, Science and Art Department, will deliver an address on "The Condition of Applied Art in England, and the Education of the Art Workman."

MAP OF NEW ZEALAND.

With the present number of the *Journal* is issued, as a supplement, a map of the King Country of New Zealand, to illustrate Mr. Kerry Nicholls's paper on "The Volcanic Eruption in New Zealand" (see page 174).

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Two Gold Medals and Four Silver Medals for prime motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows :—

1. The motors will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class.

(A.) MOTORS IN WHICH THE WORKING AGENT IS ALSO PRODUCED.

Steam.—Ordinary portable or semi-portable non-condensing engines.

Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer.

Petroleum vapour.

Liquid petroleum.

(B.) MOTORS TO WHICH THE WORKING AGENT MUST BE SUPPLIED.

Steam.—Detached engines, non-condensing, without boilers.

Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas.

Hydraulic.—Water motors.

2. Each class will be subdivided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p. No motor will be worked at a greater power than that at which it is entered.

[The horse-power herein mentioned is equivalent to 33,000 lbs. raised one foot high in one minute, as measured on the brake.]

3. For four-horse power and under, the entrance fee will be £10; above four-horse power, the entrance fee will be £2 10s. per h.p. The fees to be paid on entry.

4. No competition will be held unless ten motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The Council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the Regulations of the Royal Agricultural Society, viz. :—

a. All motors or producers under more than nominal pressure must be fitted with a pressure gauge. Before any motor can be worked, the pressure gauge must be verified by the judges.

b. There is no restriction as to the construction of motors, boilers, or producers, but the judges must be satisfied that the bursting strength of them is at least four times the working pressure, and that a hydraulic test of one and a half times the working pressure has been satisfactorily applied, if considered desirable.

c. Each exhibitor must declare the greatest pressure at which he proposes to work his motor.

d. No old boilers—that is, boilers that have manifestly been at work for a considerable time—will be admitted without special thorough examination, and a certificate of safety from the judges.

e. Each boiler, of whatever form or size, must be provided with the following mountings :—

Two Safety Valves, each of sufficient size to let off all the steam the boiler can generate, without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set.

Two Sets of Gauges for ascertaining the water level.

One Steam Pressure Gauge, which must be tested and verified by the judges before the boiler can be used.

A Half-inch Cock, terminating in a half-inch male gas thread, for the purpose of receiving a testing pump.

One Check Feed Valve, immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water level, or where there is a length of feed pipe between the engine and boiler.

f. Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges require it.

g. Shafting, belts, gearing, high speed machinery, and any other exhibits likely to prove dangerous, shall be securely fenced and protected to the satisfaction of the judges, but such approval shall not relieve the exhibitor from his own liability.

8. The points of merit considered of the greatest importance are—

a. Regularity of speed as to revolutions per minute under varying loads.

b. Regularity of speed during the various parts of one revolution.

c. Power of automatically varying speed to suit arc lights.

d. Noiselessness.

e. First cost.

f. Cost of running.

g. Cost of maintenance.

[In estimating the comparative value to be allotted to each of these points of merit, the judges will give due consideration to the characteristics of each kind of motor, steam, gas, water, &c.]

9. The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal* of the Society of Arts. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the Society, all claims in respect of damage (if any) resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

12. All costs of fitting up and working the motors must be borne by the exhibitor. The Society will provide the brakes, indicators and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

Forms of entry can now be obtained on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post-free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Friday, January 21, 1887; MALCOLM LOW, M.P., in the chair.

The CHAIRMAN, in introduciug Mr. Saunders, remarked that there were three essentials to the success of such a meeting—first, that the subject for discussion should be an interesting one, and on that point there could be no doubt, for this country—the Bam-i-duniah, or the Roof of the World—was interesting as forming a point in the most tremendous mountain system in the world, and from its watershed flowed the early affluents of the great river systems which fed the Caspian, the Bay of Bengal, and the Persian Gulf. Not only that, but the country had been looked to from time immemorial with the greatest interest, and from all time it had been the meeting ground of the Mongol, the Turanian, and the Aryan races. It was also interesting in modern times as the point where the dominating nations in Asia—the Russians, the Chinese, and the English, were meeting together. The second essential was that there should be a competent lecturer, and on that point also there could be no doubt, Mr. Saunders being well known as a distinguished cartographer who had made a special study of this particular region. The last condition was, that there should be an intelligent and appreciative audience, and on that point he felt sure that, while many present were specialists on Central Asian questions, they had all come prepared to enjoy the paper which so learned an expert was prepared to put before them.

The paper read was—

THE UPPER OXUS AND THE BAM-I-DUNIAH.

By TRELAWNEY SAUNDERS.

The Upper Oxus is the mountainous part of one of the rivers that drain the Bam-i-duniah, or Roof of the World, the lofty table-top of a very notable mountain knot which connects the principal mountain systems of the Asiatic and European continents, while it is also interposed between the great plains or lowlands of these quarters of the globe.

TheBam-i-duniah is also called the Pam-er, a name of like significance, for it means the Roof of the Mountain. The Bol-or is another name of this lofty plateau, with a similar meaning. "Bol" is the same as Bala—above

or upper; and "or" is equal to *ar*, a common word for mountain in Eastern languages.

Colonel Gordon, in describing his visit to the Bam-i-duniah, under the late lamented Sir Douglas Forsyth, remarks that "a" in *ak* is sounded exactly like "o," and Captain Biddulph observed thereupon, that *Aksu*, or white water, pronounced "Oksu," suggests the classical name Oxus. So *Bal* becomes "Bol," and *ar* becomes "or," through spelling according to local pronunciation. Bal, as a nominal affix, is of very ancient use in this region, and still continues in the well-known name of Balti, which was recorded by the Greek geographer Ptolemy, in the second century of the Christian era, as Bultai (Βυλται).

In this paper the Bam-i-duniah is considered, firstly, in relation to the great mountain girdle surrounding Central Asia, of which it is an important central part; secondly, in relation to the great plains, and seats of population and trade on each side, and the mountain routes between them; thirdly, as the meeting place of great and distinct divisions of the human race at the present day; fourthly, as the primitive seat of the human race, according to a concurrent interpretation of the most ancient sacred books of four distinct Oriental races—the Hebrews, Persians, Hindus, and Chinese; fifthly, and finally, as the ground on which three great Asiatic Empires have come into contact—British, Chinese, and Russian—the boundary lines being unsettled, and bearing on the security of the Indian frontier and the restriction of British trade.

I.—The Mountain System.

A fundamental feature of the Asiatic continent is the vast girdle of mountains that encloses, as in a ring-fence, the immense pastoral plains and plateaus of Central Asia, a region which is almost wholly included in the Chinese Empire. Some writers describe Turkestan and Persia as Central Asia; but as those regions are included in the limits of the continent, it would be incorrect to follow them. A few words explanatory of the mountainous girdle or zone of which the Bam-i-duniah is a central part, should give an impression of the far-reaching connections of the Roof of the World; and if the view be discursive, it will perhaps be excused when it is found further on that under other aspects also, the Bam-i-duniah is well entitled to its name.

The mountain girdle of Central Asia may be very briefly described in four parts:—

1. The southern part is formed by four principal parallel chains, including the highest summits in the world. The first and second chains are the outer and the inner Himalaya; the third is the Karakoram and Gang-ri chain, forming parts of the same continuous line; and the fourth chain is the Kuenlun range. The Himalaya and the Kuenlun uphold between them the lofty plateau of Tibet, the mighty mass being interposed between the plains of Northern India on the south, and the plains of the Gobi on the north. The Gangri and Karakoram range is notable, because the Gangri divides the Sanpu, or upper part of Brahmaputra river from the inland drainage of the Tibetan lakes; while the Karakoram mountains divide the Indus basin from that of Lake Lob in the Gobi plains. The lake is the recipient of the Yarkand and Kashgar rivers, that drain the eastern part of the Bam-i-duniah. The summits of the Kuenlun and the outer Himalaya approach most nearly where they support the Bam-i-duniah on its eastern and southern flanks respectively, at a distance of 300 miles apart; but on the 90th Greenwich meridian, these ranges, forming the outer buttresses of the Tibetan plateau, are separated by a distance of 600 miles.

2. The northern division of the mountain zone has the Thian Shan, or Celestial mountains on the south, bounding the Gobi plains in continuation of the Kuenlun mountains. Beyond the towns of Hami and Barkul, the depression of the Lob Nor basin is succeeded by a general elevation of the Gobi plains eastward, and the Thian Shan sinks into comparatively low hills, which connect it with the water-parting of the great Yenisei basin running in a north-easterly direction up to the Kentai mountains. East of the Kentai mountains, the Central Asian girdle is continued up to the Khinghan mountains, which belong to the western division of the system.

The outer side of the northern division of the girdle begins on the west in a prolongation of the Thian Shan mountains, descending to the Kirghis plains between the Aral sea and Lake Balkash on the north, and the right bank of the Jaxartes river on the south. Smaller ranges divide the Balkash plain from the more elevated Mongolian plateau, and connect the Thian Shan with the Altai system, which, under various names, runs eastward to the Sea of Okotsk and Behring's strait, and divides the Mongolian plateau from Siberia. The northern division of the girdle is much less elevated, and less regular in its structure

than the southern; but both bound the intermediate depression of the Gobi, and both are occupied by pastoral people, under the sway of China, and are chiefly of the Buddhist or Lama religion.

3. The eastern division of the mountain girdle connects the north and south, by means of the Kinghan mountains between the Amur river and the Hoang-Ho, and dividing Mongolia from Manchuria and Northern China. From the Hoang-Ho to the eastern extremity of the Himalaya—on the water-parting between the basins of the Yang-tze and Bramaputra, on the east of Assam—the girdle is formed by the Yun-ling mountains, dividing Kokonor and Tibet from China Proper.

4. The western division, connecting the Thian Shan with the Himalaya, the Karakorum, the Hindu Kush, and Kuenlun, completes the circuit of Central Asia, and forms the special subject of this paper.

At the head of the Jaxartes river, called the Narin in its upper course among the mountains, and also the Sir and the Sihoon on the plains, the Thian Shan mountains throw off a branch along the right bank of the river, which has already been mentioned with reference to the plains of the Aral and the Balkash.

A considerable inlet of the vast Turkoman plain penetrates the mountains and forms the plain of Ferghana. It is washed by the Jaxartes. This inter-montane lowland lies between the northern branch of the Thian Shan mountains and the main chain. The latter follows the left bank of the river, and forms an important water-parting, dividing the Jaxartes basin from the basin of Lake Lob, until the chain is crossed by the Terek Pass, when, continuing westward under local names, the main chain of the Thian Shan serves still as a waterparting, but now divides the Jaxartes from the Oxus basin, where the main chain runs along the northern side of the Alai valley, watered by the Kizil Su, a headwater of the Surkab or Waksh.

Near the Alaudin Pass the chain becomes the water-parting between the Jaxartes and the Zarafshan until it terminates in the Kara Tau (hills). On the north of Samarkand, the western termination of the main chain of the Thian Shan, lies nearly in the same meridian as that of its northern branch, and the end of the southern branch does likewise. The main Thian Shan throws off a lofty branch at the head of the Zarafshan river and glacier. The southern branch divides the deep and narrow Zarafshan valleys from the middle course of the most northerly affluent of the Oxus, called the Surkab or Waksh, where it passes through the State of Karategin. The upper course of the Surkab or Waksh will be noticed after disposing of the prolongation of this southern branch of the Thian Shan, westward of Karategin, and the mountains emanating from it. They terminate westward in the plains of the Zarafshan and Oxus, where the mountains are skirted by the lowland road from the Oxus ferry at Kelif, to the Bokharian town of Karshi and the famous City of Samarkand, seized by Russia in 1868, along with the rest of the Zarafshan valleys.

The southern branch of the Thian Shan mountains maintains a great elevation up to the culminating summits of its western extremity, where it spreads out from the Sultan Hazrat Peaks in a great crescent northward to Samarkand and southward to Sherabad on the Oxus. Sharizabs, the summer residence of the Amir of Bokhara, is on a plateau beautifully watered by the Kashla river, embosomed in the northern part of this mountain crescent, while the famous iron gates of Derbend defend a stupendous gorge in the southern part.

Between the Sultan Hazrat Peaks and Karategin the southern Thian Shan range throws off southwards a succession of spurs with intermediate valleys watered by the Surkhan or Tufalan, and the Kafirnahan rivers, and also another spur forming the western frontier of Karategin, and separating the lower course of the Waksh river from the vale and river of Kafirnahan. This alpine region forms the State of Hissar, subject to Bokhara. The Tufalan joins the right bank of the Oxus, called now the Amu, at Termez. The Kafirnahan joins the same main river below Kabadian. The Waksh falls in a few miles further east. These rivers having their sources in the Thian Shan ranges, join the Oxus after it has emerged from the western division of the great mountain zone, to flow westward through the Bactrian Plain. This famous plain is another remarkable inlet penetrating far into the midst of the mountains in continuation of the vast Aralo Caspian lowland, just as the Plain of Ferghana, already noticed, does further north. These inlets exercise an important influence on the western division of the central girdle, and on the commerce of the world, inasmuch as they facilitate the interior traffic of the Asiatic Continent between the east and west, by shortening the

passage across the mountains, along two parallel routes about two hundred miles apart.

When the Russians entered Ferghana Plain in 1864, Prince Gortchakoff issued a famous State paper, declaring that Russia had reached her natural and proper limits, and that even the misconduct of the neighbouring States would not induce the Czar to pass those limits, except as a temporary measure, even if that course should be forced upon him. The prince was quite aware that this advance brought the Russian Empire close upon an ancient trade route that had existed from time out of mind; and he appeared to be apprehensive lest the danger of this route being closed by the exclusive tariff of Russia, would draw upon the Czar the combined resistance of all the commercial powers, European and American. The prince measured, by his own knowledge, the geographical ignorance of those whose anger he desired to prevent. But only a few experts, of no weight with Foreign offices, understood the commercial bearing of the Russian advance, and the rest failed to see any motive in the Gortchakoff note. Immediate advantage was taken of this indifference. The Russian frontier was advanced across the trade route, and at once the operation of the exclusive tariff was felt in the distant market of Tabriz on the north-west of Persia, where an established trade suddenly collapsed. Hitherto the destination of the trade had never been inquired into, but now it was discovered to be Turkestan, and that the Russian occupation had put an end to the business.

About the same time the British Government resolved to define the northern boundary of Afghanistan, as a line beyond which British influence should not be exercised northward, nor Russian influence southward. Afghanistan on the British side of this line, and Bokhara on the Russian side, were to become neutral States, respectively protected by the dominant power on its own side. The Oxus river, from its southernmost source in the Taghdumbash Mountains to Khoja Saleh, at the west of the Bactrian Plain, was a part of the boundary chosen between the two Empires, and so far as the Oxus flowed through the Bactrian Plain, it was truly a natural and proper boundary, being unfordable and unbridged, and serving as a flooded ditch to the lofty triple rampart of the Hindu Kush.

But the defensive character of the Oxus among the mountains on the east of the Bactrian Plain is not so simple, for its course has two distinct and contrary results.

In the first place, from its southernmost source in the Taghdumbash to the village of Ishkashm, the river flows close along, and so near to, the summit of the Hindu Kush, as to enable the passage of the mountain to be made in carts, thus completely counteracting the effect of the river on the Bactrian Plain, where it serves as a serious obstacle to approaching even the *base* of the Hindu Kush, which, rising from the plain, interposes a succession of parallel ranges, successively higher and higher, and crossed by deep and precipitous defiles after each interval.

When the rival States of Iran and Turan chose the Oxus as a boundary, their disputes were absolutely confined to the plains, and their strategy on either side never extended to the remote heights of the Bam-i-duniah and the Pamirs. Now it is far otherwise, and the defenders of India will scarcely consent to a boundary so contrary in its adjoining sections, especially when it is the section nearest to the north-western salient angle of the Indian frontier, that, by following the course of the Upper Oxus, would place an aggressive neighbour on the actual water-parting of the Indus Basin.

By adopting the stream from the Taghdumbash, or the Kilik Pass, through the state of Wakhan, the ancient trade route between Balkh and Yarkand would have been intercepted, and consequently closed; and on this account the proposed boundary was shifted to the next branch northward, which rises in the Victoria lake (discovered by Captain Wood in 1837), drains the Great Pamir, westward, and joins the Sarhad, or southern branch near Langar. The road along the southern branch is thus left free, but the frontier along the Oxus between Panjah and Ishkashm still skirts the summit of the Hindu Kush, and except the bare preservation of the trade route, the frontier here would be extremely objectionable to British interests. Hence recent proceedings have taken place to move the frontier further north, to which further reference will be made hereafter.

The second objection to the Oxus mountain stream as a frontier is combined with an advantage. Below Ishkashm, the River Oxus, or Ab-i-Panjah, is deflected from its W.S.W. course along the summit of the Hindu Kush, and strikes off almost due north, having Wakhan, Shignan, Roshan, and Darwas, on the east, and Badakshan, with parts of

the foregoing provinces, on the west. Between Darwaz and Badakshan the river reaches its northernmost points in a great bend, rounding to the westward, and descending south-westward into the Bactrian plain through a barely passable gorge between Kulab and Badakshan. This gorge, on its south side, precipitously terminates four arms of the mountain range, called Kodja Mohamed, that emanates from the summit of the Hindu Kush, on the south of Ishkashm, and on the east of the Nuksan Pass between Badakshan and Chitral. Near the pass is the Tirich Mir peak with an altitude of 25,426 feet. The Kodja Mohamed range forms the left bank of the Ab-i-Panjah river in its passage from Ishkashm to the Bactrian plain. It is also the western termination of the Pamirs of the Ab-i-Panjah basin, dividing this part of the lofty Bam-i-duniah from the much lower country of Badakshan, which is nevertheless considerably higher than the Bactrian plain. Badakshan is divided from the plain by a mountain spur connected with the Hindu Kush near the Khawak or Inderat Pass, on the road between Kabul and Kunduz.* The spur is crossed on the road between Kunduz in the plain, and Fyzabad in Badakshan, by the Lataband Pass, which has an altitude of 4,920 feet above the sea. Occupying the whole of the highlands in the midst of the great bend of the Ab-i-Panjah, Badakshan flanks the plain of Bactria at a superior elevation on both sides of the Oxus, but Badakshan is itself similarly flanked at a superior altitude by the Pamir countries of Wakhan, Shignan, Roshan, and Darwaz, which are watered by the Ab-i-Panjah on its northward course, and lie along the eastern side of the Kodja Mohamed mountains, so as to look down (as it may be said) upon Badakshan, as Badakshan looks down on the Bactrian plain. Therefore, while Badakshan has an advantage in the northward bend of the Ab-i-Panjah, that advantage would be made untenable by following the river as a frontier, and thus placing the Pamir states under another power. By the occupation of those states an aggressive power would also be placed in a similarly threatening position on the water-parting of the Indus basin, and on the present north-west frontier of India.

* The Inderab valley proceeds westward from the Khawak pass in a lateral valley, nearly parallel with the summit of the Hindu Kush. The Wakhan valley farther east has the same parallel relation to the Hindu Kush; and it is probable that the Inderab valley is succeeded eastward by a lateral valley connected with the Jarm branch of the Kokcha.

The northern side of the bend of the Ab-i-Panjah is in Kulab, and is a part of the western termination of the northern Pamirs. These mountains divide the secondary basin of the Surkab or Waksh from that of the Ab-i-Panjah, whichextends from the main chain of the Thian Shan mountains, between the Shart Pass and the noted Terek Pass, the latter being on the old trade route between Ferghana or Khokand and Kashgar.

The northern limit of the Bam-i-duniah is the main chain of the Thian Shan mountains, where that chain divides the lofty Alai valley on the south, from the lowland of Ferghana on the north. The Alai valley is drained by the Kizil Su, called also the Sukh Su, the northernmost headwater of the Surkab or Waksh river. A saddle divides the Alai valley from the Chinese gorges of the Kashgar valley on the east, and unites the main Thian Shan range with the parallel Alai range, rising on the south of the Alai valley in the Kaufman Peak to above the altitude of 20,000 feet, and dividing it from the Muksu and its feeders, the Kaindi and the Salisai. The Russians call the Thian Shan main chain by various names, including the Alai mountains on the north of the Alai valley, and the mountains on the south of the valley are called by them the Trans-Alai mountains; of course these mountains are only *Trans*-Alai to them. In this paper, the Alai mountains are those on the south of the Alai valley, up to the Waksh river on the west, and the Kashgar Kizil Su on the east; the Muk Su on the west, and the Markan Su on the east, being their southern base. The Alai mountains prolong the water-parting from the saddle as far west as the Kaufmann peak, from whence the dividing range turns southward, and cuts off the Muksu and the Wakshab basin from the great Karakul lake and the Murghab in the Ab-i-Panjah basin. The Muksu unites with the Alai Kizil Su at the eastern end of the Karategin state, and their union forms the Surkab or Waksh, which, after intersecting the mountains of Karategin, washes the eastern frontier of Hissar, and joins the Oxus or Amu Daria in the plain of Bactria, between Airvaj and Hazrat Imam. Summits exceeding 20,000 feet in height rise on the south as well as on the north of the Muksu valleys. Those on the south include the Fedshenko glacier on their northern slope; and up to the Fedshenko peak they form the water-parting between the

Waksh and Ab-i-Panjah basins. West of the Fedshenko peak, where this range ceases to be on the Ab-i-Panjah water-parting, it continues westward, and divides the Wakia-bala river from the Waksh, and terminates at the junction of those rivers. The continuation of the Waksh and Ab-i-Panjah water-parting westward from the southern Muksu mountains passes through the State of Darwaz. The northern part of that state is in the Waksh basin, where it includes the Wakia valley, watered by the Wakia, Kolab or Khulias river, which joins the Waksh within the southern end of Karategin State. The remainder of the Waksh and Punjab water-parting follows the left bank of the Waksh river, leaving Baljuan on the east, and after being crossed by the Tash Robat Pass at an altitude of 2,590 feet, descends into the plain between the two rivers. On the east the Ab-i-Panjah basin is divided throughout from the basin of Lake Lob, which drains all of the eastern part of the Pamir, or Bam-i-duniah. The water-parting is the Bolor meridional range, connecting the Alai mountains at Kaufman peak with the Karakoram and Hindu Kush mountains at the Kilik Pass, which is the common point of junction of the three ranges, each of which forms a distinct water-parting. The Bolor range was crossed at the Neza Tash Pass, 14,920 feet, by survey officers with the late Sir Douglas Forsyth's expedition to Kashgar and Yarkund in 1873.

Two of the head waters of the Ab-i-Panjah river, and the main stream which is formed by their union above Kila Panjah, have been already noticed, and the main stream has been traced through Wakhan, along the summits of the Hindu Kush to Ishkashm, where the river is 8,700 feet above the sea. Thence almost due north by Shignan, Roshan, and Darwaz, and the eastern flanks of the Kodja Mohamed range, the Ab-i-Panjah drains a part of the Bam-i-duniah, and receives from it one considerable affluent named the Ak Su, the Bartang or Murghab, and other mountain streams of less account. The principal of these affluents, the Ak Su, rises in the Little Pamir, and flows out of the Oikul, Gaz Kul, or Goose Lake. Through the Western part of the Little Pamir the Sarhad river flows, being the southernmost affluent of the Ab-i-Panjah, while the Ak Su, rising in the Goose Lake, flows first to the north-east, then north, along the eastern water-parting of the basin called the Bolor range, and finally bends round to the westward at the Sares Pamir, and receiving the Ak-baital on its right bank, from the Rang Kul lake and Pamir, joins the Khund from the Yeshil Kul and Alichur Pamir, and the Shakh Daria from the south side of the Drum mountain, and finally unites with the Ab-i-Panjah, near Bar Panjah in Shignan.

The mountains between the Ak Su and the Hindu Kush are isolated from the mountains on all sides by the Ak Su and Ab-i-Panjah rivers, which surround them. This circumstance appears to have led some writers to regard the whole of the Bam-i-duniah as a confused mass. This opinion might be detrimental in the future settlement of the Imperial frontiers, and is quite contradicted by the present paper.

The great Karakul lake drains the Kargosh or Hare Pamir, in the northernmost part of the Ab-i-Panjah basin; unless reduced by drought, the lake falls into the Kudara, a branch of the Murghab which joins the Ab-i-Panjah at Kila-Wamar. The mountain range that rises between the Ak Su and the Murghab emanates from the Bolor water-parting on the Kara-art Pass. The Badakshan side of the main river is drained by minor streams, the chief of which flows northward from the Shiva or Pamir Khurd, and another comes from the Ragh district, both being between the northern arms of the Kodja Mohamed mountains. It is reported that Shignan and Roshan have been found to be dependencies of Badakshan, and as such they have been brought within the British boundary, as they need to be.

The eastern part of the Bam-i-duniah, or Pamir, now falls under review. It drains into the Yarkand and Kashgar Kizil Su rivers in the basin of Lake Lob, and is the western extremity of the Chinese Empire. In the settlement of the respective frontiers of the three empires, an early arrangement between the British and Chinese Governments seems to be advisable. The northernmost termination of this eastern side of the Bam-i-duniah is the upper basin of the Kashgar Kizil Su river, bounded by the main chain of the Thian Shan mountains on the north, and by the Bolor water-parting range on the west. On the south the basin is bounded by a range connecting the Bolor mountains with a parallel range on the east, which forms the eastern limit of the Bam-i-duniah. This is the Tagharma range of mountains, with snowy peaks that rise up with great boldness on the west of the plains of Yarkand and Kashgar, and connect the Kuenlun mountains on the south of the plains

with the Thian Shan mountains on the north of them. It is a range of the first class in respect of altitude, for at least two of its measured summits rise above twenty thousand feet in height, the Tagharma peak being 25,500 feet above the sea, while another peak, divided from Tagharma by the Gez defile or gorge of the Yamanar river, is 22,500 feet. The Tagharma range is intersected by the gorge of the Kashgar river at the fort of Kurghashim Khand, which is itself 6,760 feet above the sea, the height of the summits on either side of the gorge being unobserved. The Tagharma mountains unite with the main Thian Shan between the Turt-kul and the Tuz-ashu Passes. The connecting range on the south of the Kashgar river forms the right bank of that river as far west as its confluence with the Markan Su river, and it joins the Bolor mountains on the south of the Kara-art Pass (16,000 feet), between the Markan Su and the great Karakul. Southward, for more than a hundred miles, a broad and lofty plain divides the parallel ranges of Bolor and Tagharma. This is the Tagharma plateau, or Pamir, which is succeeded on the south by the Sarikol and the Taghdumbash Pamir. The latter occupies the high land between the western extremities of the Karakorum and Kuenlun ranges, while Sarikol forms a connecting link between the Taghdumbash Pamir and the Tagharma plain. Eastward, the Taghdumbash Pamir appears to be connected with the high plains of Tibet by lateral valleys on the north of the Karakorum culminating range. The Taghdumbash Pamir is only divided by the Karakorum water-parting from Hanza Nagar, in Kanjut, the most northerly settlement in the basin of the Indus.

The Pamir is not generally considered to embrace the highland on the south of the Hindu Kush, but that opinion is not supported by the earliest British authority. Capt. Wood, the discoverer of the Victoria source of the Oxus, expressly includes Chitral, Gilgit, and Kunjut in the Pamir or Bam-i-duniah; and Colonel Biddulph agrees with General Cunningham in regarding the fort and town of Skardo, on the Indus, in Baltistan, as the capital of the ancient Bolor kingdom. In Gilgit and Kunjut, and all the valleys westward, according to Colonel Biddulph, Skardo is still known only by the name of Palor, Balor and Balornts. In 1883, Mr. Mac Nair found Balti people serving as porters on the mountain route between Dir and Chitral, thus practically illustrating the intercourse between the people of the Upper Indus and Chitral valleys. It was explained at the beginning of this paper that Balor, Pamir, and Bam-i-duniah, have all the like meaning. The true natural limitation of the Bam-i-duniah is to be found in the exterior buttresses, or mountain sides that support it, and in the bases of these buttresses which rest upon the great plains of the Punjab, the Gobi, Bactria, and Ferghana.

On the side of the Panjab the base line, and the culminating summits that define the exterior buttress in this direction, are more obscure than in the other cases. The base line of the Outer Himalaya must not be sought for in the open plains of Northern India, but in the duns or doons, as the valleys are called, which divide the Siwalik hills from the foot of the mountains. The Kotli doon, watered by a branch of the Poonch Tawe and the Sanjela doons, distinctly mark the Outer Himalayan base line up to the Jhelum river, which the base line may be considered to cross at Owen Ferry. On the west of the Jhelum, the Sewalik system undergoes a great change and becomes broadly developed, so that the Potwar, or Plain of Rawalpindi, is treated by Mr. Wynne in the records of the Geological Survey for 1877, as the equivalent of the doons. The base of the Outer Himalaya between the Jhelum and the Indus, thus falls along the Ling and the Sohan channels, the Marzala Pass, and the Sirun river, crossing the Indus at Torbela. West of the Indus, the base of the Outer Himalaya is the northern edge of the Peshawar plain to the gorge of the Kabul river, then that river to its reception of the Panjshir, and the latter to the Khawk Pass, where the Outer Himalaya joins the Hindu Kush.

The culminating summits of the slope rising from that base-line represent the range of the Outer Himalaya, and the southern limits of the Bam-i-duniah, Pam-er, or Bol-or. It is the westerly continuation of the Pir Panjal on the south and west of Kashmir, continued in a north-westerly direction across the Kishen Gunga and Khagan rivers, and on the Indus, near Palas, its summits rise to 16,600 feet on the left bank, and to 14,900 feet on the right. Its peaks cross the Swat river near Mankial, and it is surmounted between Dir and Ashreth on the Kuner river, by the Lahuri Pass. West of the Kuner river, the Outer Himalaya embraces in its unconquered fastnesses the primitive people of Kafiristan, whose future is watched with the greatest interest, and entails a grave responsibility. In another point of

view the Outer Himalaya may be continued across the Kabul river to the Karkacha Mountains, and so on to the Arabian Sea. The outer line of summits is not to be confounded with the range of the Inner Himalaya, to trace which it is necessary to begin with its own base-line. That line is found in the River Indus traced through Baltistan to its confluence with the Gilgit river, thence along the Gilgit to its confluence with the Ghizar, and along the Ghizar to one of its sources that affords the best connection with the Kunar river at Mastuj, descending the Kunar to the entrance of the gorge, which marks the passage across the Himalayan summits. The lofty Nanga Parbat (altitude 26,620 feet) is on the line of the northern, or Inner Himalaya, on the left bank of the Indus. On the right bank, the range commences on the north of Gor, and it divides the affluents of the right bank of the Indus from those of the Gilgit, Ghizar, and Kunar rivers. It is crossed by the Pai, Cachi, and Tal passes. The mountains which divide Chitral from Kafiristan on the west of the Kuner, seem to connect the Inner Himalaya with the Hindu Kush. British officers have been for some years engaged among the chiefs of these highlands south of the Hindu Kush. Gilgit, Yassin, and Kanjut are said to be brought under the Rajah of Jammoo. Perhaps Chitral may follow under the same rule. Kafiristan, in midst of the Kabul, Badakshan, and Chitral still holds its own against Mohamedans, and they have long since won sympathy from the British people, they have also attracted the notice of the Russians. These highland states lie in the hollow between the Hindu Kush and Karakoram on the north, and the Inner Himalaya on the south. Between the Inner and Outer Himalaya are found the petty highland states of Gor, Chilas, Darel, Tangir, and Kalam on the head waters of the Swat river, and to these may be added Dir and Kafiristan. The mountaineers of the outer slope of the Himalaya do not belong to the Bam-i-duniah.

To summarise the foregoing investigation, it may be remarked that the Bam-i-duniah is built up by four latitudinal and parallel ranges, namely:—The Outer and Inner Himalaya, the Hindu Kush, and the Thian Shan. These are connected by four meridianal and parallel ranges, namely:—The Latabund, the Khoja Mohamed, the Bolor, and the Togharma. From these all the rest of the hills emanate, with the exception of those between the left bank of the Ak Su and the right bank of the Ab-i-Panjah above Ishkashm. Accepting the Oxus in the lowland as an excellent dividing line between imperial organisations of the most opposite character, north and south of the lowland river, it follows from this examination of the highland that nothing less than the entire basin of the Oxus in the mountains can duly support the southern side of the lowland line. No doubt the lowland Oxus line has been turned on its western flank, and possibly the true frontier line in that direction, comporting with the lowland Oxus, has not been perceived. That subject is beyond the present purpose, but the settlement of the mountain frontier should not lead to a similar result, should not expose the salient angle of the north-west frontier of India.

The ancient and modern occupation of the Bam-i-duniah can only be noticed very briefly. It has been the seat of a Tajik or Iranian-Aryan population from the earliest times. It is the north-eastern outpost of the Medo-Persian people, from which, through the impregnability of its mountain fastnesses, they have never been dislodged. When Alexander the Great overran the Empire of Darius Codomannus, his work would have been incomplete if he had left this ancient if not pristine seat of the Iranian people beyond the reach of his arms. It was no Quixotic purpose that led the great conqueror to the Yaxartes. About two centuries earlier (559 B.C.) Cyrus also signalised his accession to the Persian throne by marching to the same border of his new dominions.

Some writers have concerned themselves about the time when the Tajiks migrated to the Bam-i-duniah and its neighbourhood; but the Zend-Avesta, the sacred Scripture of the ancient Persians, in a chapter which a high authority regards as having been written more than 1200 years B.C., points to the Bam-i-duniah as Aryanem Vaejo—the first region, and on other authority, the primitive seat of the Aryans. The next country mentioned is Sughda, in Gâu, or the region between the Oxus and Yaxartes, then Mouru, or Merv, on the Murg-ab, and fourthly, Bakhdi with the tall banner, identified with Bactra, where for the present purpose the reference may cease, though the list extends to sixteen Iranian countries.

As the primitive seat of mankind after the flood, other indications point to the Bam-i-duniah. In the authorised English version of the Hebrew Scriptures it is said, "as they journed from the East, that they found a plain

in the land of Shinar; and they dwelt there." Shinar is well known to be Babylonia. The oldest sacred books of the Hindus, state that their ancestors who occupied Bramavarta, between the Sutlej and Jumna, came from the north-west. The earliest Chinese sacred text places the first settlements of that people on the Hoangho or Yellow River, and it is said by Dr. Legge that they came from the west. These three widely separated witnesses, all point to the same region as the ancient Persian books, and make the Bam-i-duniah the primitive seat of mankind. Baron F. von Richthofen, in his great work on China, places the probably primitive seat of Chinese civilisation in the plain at the foot of the Bam-i-duniah, where Yarkand and Khoten now stand. The Hindus look to the valley of the Kabul river and other valleys among the hills on the north of Peshawar, as their ancient seats. The learned Dr. Wilson writes, "that an Indian population occupied Afghanistan from Kabul to the sea for many centuries before and after Alexander the Great." And it has been already seen that the Iranians have never budged from their highland homes. Wilkinson, in his famous work on the Ancient Egyptians, says, "it is not improbable that those two nations (Hindus and Egyptians) may have proceeded from the same stock, and have migrated southward from their parent country in Central Asia." The name of Tagharma is not only attached to the highest summit of the eastern range of the Bam-i-duniah, for it also occurs repeatedly in the same neighbourhood. The name occurs four times in the Bible, namely, twice as a son of Gomer, once as famed for horsemen, and once as a part of the force to be led to destruction by the Prince of Rosh. It is also identical with an old name of the country, Tocharistan.

It is much more reasonable on these accumulated grounds to regard the Bam-i-duniah as the Ararat of Noah, than the Armenian Peak of Agridagh, which is barely accessible by an Alpine climber, and quite impossible as a settlement. Its meaning corresponds with that of the Bam-i-duniah, being the mountain mount, the repetition being superlative. The Armenian Ararat was only heard of subsequently to the conversion of the Armenian nation to Christianity, and according to Canon Rawlinson, St. Jerome is the first western author who places Ararat on the Araxes. Jebel Judi, on the Tigris, north of Nineveh, is another site venerated by pilgrims as the Ararat of Noah. But this site, as well as the Agridagh, is north of the Plain of Shinar, whereas the descendants of Noah came from the east (*mi-kedem* in Hebrew, *mi* signifiying from). It is regretted that the revisers of the Authorised Version of the Bible have adapted the passage to the Armenian site as far as possible, by omitting the preposition, and leaving the passage thus, "as they journeyed east." In the margin they add, "or, in the east." This makes the matter worse and worse. For "as they journeyed east" means eastward, that is, it may be supposed, from the Hor-a-hor, the highest summit of Mount Lebanon, which would be a new site. The alternative, "in the east," is unmeaning, for on any point of the compass round the land of Shinar would still be in the east.

The interest in the Bam-i-duniah as a meeting point of races is not confined to antiquity. Itself Iranian, it has Turanians or Turks, Chinese and Mongolians, on its northern quarters, Shemitic Afghans, and Hindus on the south. Aryans, Turanians, and Mongols are the most distinctive forms of mankind in the old world, excluding Africa; Mohamedans, Buddhists, and Brahmans here also find the borderland of their great religions. Mr. Drew, in his unique work on Kashmir, points to the Nun and Kun peaks as the actual parting of Moslem, Bod, and Hindu. Mr. Atkinson, in his large and learned *Official Gazetteer* of the Himalayan districts of the North-West Provinces, adopts Kafiristan as the meeting place of Turanian, Iranian, and Aryan. Now it is to become the meeting place of the British, Chinese, and Russian Empires. The old conflict of Iran and Turan, prehistoric in its origin, constant in its durability, varying only in degree, is assuming a fresh phase, and one in which the trade and reputation of the English people and Government are directly involved.

DISCUSSION.

Mr. C. E. D. Black said he should have been glad if Mr. Saunders had given a more definite indication of what he considered should be the boundary between Russia and England on the Upper Oxus. Such a definition seemed very necessary at present, because the arrangement come to in 1872, between Lord Clarendon and Prince Gortchakoff, was that the river should form the boundary between the States subject to the influence of those two powers; but, at the present moment, this arrangement was nugatory, because some subjects o

Bokhara lived south of the river, and some subjects of the Amir of Cabul lived to the north-east. A suggestion had been made that an exchange should take place, and he believed that was favoured by the Russian Government, who were ready to take over the sovereignty of the people to the north, if the Amir would take those to the south, but he was not quite sure that that would be a fair bargain. Anyhow, it was very desirable to have a satisfactory boundary laid down, to avoid the risk of a breach of the peace which might easily spread very largely.

General RUNDALL said he did not quite follow Mr. Saunders in his reference to the journeyings eastward of the descendants of Noah. The district described was no doubt a very interesting part of the world, especially having reference to the deduction which might be drawn with reference to the part that Kafiristan was to play in the present day. The people of Kafiristan were certainly a very unique race, planted in the midst of a still more unique race, the Afghans themselves.

Mr. LEPPER remarked that, in the East, the divisions of countries were seldom or never marked by rivers, but nearly always by watersheds. The definition of any boundary by a river, therefore, in Oriental countries, would be almost sure to lead to complications. As an instance, he might refer to the Great Wall of China, which, throughout its enormous length, was taken up to the tops of the mountain ranges, down to the gorges, and up to the summit again. Even in the division between Tibet and China the water-parting was selected as the boundary. This fact ought to be recognised in arranging the boundary in question.

Mr. MARTIN WOOD said this paper was as complete and satisfactory as it could be; but here and there he could trace a certain vein of polemic which somewhat affected its value to his mind. Mr. Saunders spoke of the ring fence afforded by these mountains to the plains of Central Asia, and he would ask whether those mountains on the southern side were not the natural ring fence of India itself, enclosing it, and barring it off from the rest of the world, except from intrepid travellers, and hardy mountaineers. If we had such an impregnable defence, why go beyond it? Then, again, reference was made to "our imperial frontier through the Pamir regions." He should like some experienced administrator to define how we could in any sense speak of this as our frontier. It seemed to him that the idea that we were bound to guard these immense limits, and were responsible for them, introduced a very serious element of confusion and uncertainty. What was the base from which these limits were to be dominated, and what was the material available? India, and the finances and resources of India. So long as this view was held, no doubt these expansive notions of political geography would be received with much complacency, but he did not think they would receive much acceptance in the House of Commons if the British Treasury had to form the financial basis of this topography. In saying this, he did not in the least deprecate the fullest inquiry and acquisition of knowledge on this subject, but political responsibility was quite another matter. He was very glad that Mr. Saunders had referred to the discovery of the Victorian source of the Oxus, by a member of that famous old service which, in many respects, prepared the way for the more recent and scientific examinations of the topography of this region. Mr. Saunders had referred to the ancient conflict between Iran and Turan, and no doubt there had been such a conflict, and these racial difficulties did endure through many changes, but it need not be assumed that they would never cease. In the present century people had come to believe that these difficulties were very largely modified, and it was hoped would eventually be completely overcome by the operations of modern commerce, and the spread of information. In conclusion, he desired to take that opportunity of expressing his regret at the comparatively premature decease of Sir Douglas Forsyth, a member of the Society, who had travelled over these regions, and whose name was familiar in connection with these questions.

Mr. HYDE CLARKE said he had listened with great interest to Mr. Martin Wood, and he noticed his anxiety for the protection of the people of India from the expenses to which they might be exposed in the maintenance of this shadow of boundary, as he had called it, but was there not another side to the question. Did not that boundary itself, even with the Khanate of Badakshan, constitute a road from the other side for attacking the people of India at that very point which Mr. Wood said was so sensitive, their payment of revenue, he might have said their possessions, their liabilities, and their lives. It was well to be sentimental on behalf of those under our protection in India, but something more than sentiment was required, and that was to give them a real and effective protection. How had they come to Badakshan itself? Because in the nature of things those States were outlying parts of Cashmere, and we had been brought there in the natural course of events, but if brought there for one purpose we might be kept there for another. If they could persuade their friends, the Russians, to be actuated by the same principles as Mr. Wood, and to have a very strong desire for the cultivation of commerce, particularly that of foreign nations, there would be some basis for co-operation. If Mr. Wood were talking about China, for instance, he could understand there might be such a common basis and such connection with regard to commercial pursuits; but if there was one

fact better known than another, and they had been reminded of it by Mr. Saunders, it was that wherever Russians went the trade of other countries practically ceased. The period for sentiment, therefore, was gone; Englishmen must look not to their own selfish interests simply, though they had a right to look to them as well as other people, but they must look to the interests of India with an ever-growing population, and to the enjoyment of those resources which they might obtain from those very countries. Step by step the trade of India, wherever it was possible, was stopped by the Russian advance, and so it would be in the future. The advance of Russia, even if it were an advance in the interests of civilisation on the one side, and of pacific government, was directly contrary to the material interests of the people of India and of their British protectors. The subject of the paper was wide enough in itself; but not content with that and its present application, the author had gone back to the period when Noah left the ark, and left his hearers in some doubt on what mountain our forefathers were placed, and when they began to distribute themselves throughout the world. Where the subject is so wide one has sometimes to deal with a trivial detail. As for Oxus, there is ground for treating *úh* as *aw*. Within the last two centuries, the change of vowel sound has taken place in Turkish as in the European languages, but whether coming from the west or from Persia is not clear. This will not, however, make Oxus into Aksu, because in the Greek transcription, *xi* or *ks* transliterated stand for *sh*, or as *shin* in Hebrew or Semitic. There is, however, no sufficient ground for believing that the Turks had risen to power at the period referred to; and besides, Oxus assimilated to Axios and well-known forms in ancient geography. This was a trivial matter, but Mr. Saunders had raised a much much more important question with respect to the Chinese. If we could not settle our relations with the Russians in the way Mr. Martin Wood wanted, and get them to establish some great fair, such as we had set up on the frontiers of India—a fair in Central Asia where commodities could be exchanged—it was very desirable that we should come to some arrangement with the Chinese. With regard to Badakshan, the Chinese had claims there also, but the present period was very favourable for coming to some arrangement with them, as they had the same interests as ourselves. It was very desirable not to draw a hard and fast line, but to endeavour to come to terms with those who might be our allies and our customers.

Mr. Trelawney Saunders, in reply, expressed his acknowledgments to those who had brought their minds to bear on this subject at so short a notice. The difficulty he had found in dealing with it had been to restrict the paper to reasonable limits, and if he were to respond to the invitation given him, to expand first in the direction of the Deluge, and next in that of the British boundaries, he feared each of those points would require a night to itself to do justice to it. He was quite prepared to meet Mr. Wood—though he took a diametrically opposite view—if he would give him the opportunity of doing so; but he did not think it would be reasonable to expect him to do so on that occasion. With regard to Mr. Black's invitation for him to define what he thought should be the boundary, he had done it so far as he ought to be called upon in the paper. He said distinctly that, as a geographer, and looking to the facts of the case, in ascending from the Oxus in the lowlands to the Oxus in the mountains, the basin ought to have been substituted for the river. He was quite prepared to expect, however, that no Government of the present day would support such an idea, because it was a day of weak Governments and weak people. He had given his recipe in general terms, and if he were asked to apply it, he should be put on the Commission which would have to arrange it. He had not endeavoured to persuade his audience of any opinion of his own on the subject of the Deluge; he had simply brought forward the evidence of antiquity, in particular one chapter containing invaluable geography in the Zend-Avesta, and had referred to so much of it as he thought necessary for the purpose. It was easy to pursue the subject further, but, for his part, he came to the conclusion that there was no part of the world claiming to be the Ararat of Noah which was so well supported by evidence as the Bam-i-duniah. There were valleys there which would have formed sufficient space for a pristine settlement, and they were told in the most remarkable detail that the people who occupied them at first were driven to seek other settlements by the snow. They found the bottom valleys sufficient at starting, but as their numbers increased, and they were forced up the hill sides and came in contact with winter snows, they could not stand the severity of the weather, and had to descend to some further lowlands into Sogdia, Merv, and Bactria. The Zend-Avesta only dealt with the Aryan countries, but Baron von Richthofen had shown them that, in all probability, just as Bactria, Merv, and Sogdia were peopled from Ariana, so Yarkand was probably the first residence of the people moving from the same centre to the east. No evidence could be stronger than that which showed that the Brahmans, the ancient Hindoos, came down into India by the valley of the Kabul river, and the affluents descending into it. Against all this testimony Armenian monks set up their native peak, which was a mass of ice at the summit, and had only been climbed by two or three persons in the whole history of the world. Mr. Lepper's remark with regard to the choice of mountain ranges for boundaries was sometimes just. He could imagine nothing more indicative of a want of forethought and consideration than to carry out an Imperial frontier between two opposite

systems, commercial and political, along the course of a river in a narrow alpine valley, every inch of which, on both sides of the stream, must be necessary to the occupation of the inhabitants. To tell the people on one side they should not cross to the other to look for a little more pasturage, because of a frontier line and all it involved, was the height of absurdity. He was a great admirer of peace, but, at the same time, those who were crying "Peace, peace, when there is no peace," with reference to this aggressive power from the north, were those who were making the conflict worse when it took place, and the conflict must come sooner or later.

The CHAIRMAN then proposed a vote of thanks to Mr. Saunders for his admirable paper. With regard to the derivation of the term Bol-or, they all knew that this Bol-or was a most mysterious region for many generations after the time of Marco Polo, and he was not sure that they had yet got at the correct derivation of the term, and would even venture to doubt whether the learned lecturer was quite correct in ascribing it to the same root as Balargat and Zeergat in the Persian. With regard to the whole topographical portion of the paper, in his opinion it was a remarkable exposition of a somewhat difficult and confused subject. With regard to the question of the boundaries, if he were to say much he should be entering upon exceedingly ticklish ground. In that Society they were strictly non-political, and if he even mentioned political considerations he should be at once exposed to the ban and *arrière-ban*. He preferred merely to mention what he conceived to be a fact at the present moment, viz., that we had undertaken that our influence should be thoroughly established for the protection of Afghanistan, and accordingly the question of the boundary between Afghanistan and the Russian Dominions became a matter of the utmost possible importance. When we learned, from one of the most recent Russian Blue-books, that the conduct of the Ameer of Afghanistan was somewhat objected to with regard to making difficulties between Shignan and Roshan, it was evident that this was a matter which it became all Englishmen interested in the subject to bear in mind. If the Russian view were here acceded to, we should come very close indeed, the Russian domination would come very close indeed to the Baroghil and Kilik Passes, on the latter of which it had certainly been said that the way even for an army was not by any means impossible. All we contended for was that practically, as we had promised to protect Afghanistan, the question of the boundary must be a question of the utmost importance, and one which we had to consider whether we wished to or not. With regard to the learned disquisition as to the resting place of the ark, he felt he could scarcely say anything of value, and must, therefore, leave that question where Mr. Saunders had left it.

FOREIGN & COLONIAL SECTION.

Friday, January 25, 1887; Sir FRANCIS DILLON BELL, K.C.M.G., C.B., in the chair.

The paper read was—

THE VOLCANIC ERUPTION IN NEW ZEALAND.

By. J. H. KERRY-NICHOLLS, F.R.G.S.

In the year 1883, in company with my interpreter, Mr. J. A. Turner, I undertook upon my own responsibility a journey of exploration through a portion of the North Island of New Zealand known as the "King Country," and which had been, since the disastrous war of 1865, rigorously closed against the intrusion of Europeans by the Maori king and the chiefs of the native tribes over whom he exercised his *mana*, or authority.

The journey extended from Tauranga, on the east coast, then southward, beyond the great mountain Ruapehu, and northward, through the King Country. Altogether, with the assistance of only two horses, and what little provisions we could carry, we covered a distance of nearly 1,000 miles; and from the level of the sea we ascended to the highest altitude attained by the most elevated peak of the North Island, or nearly 10,000 feet above the sea. It was during this journey, which occupied in all nearly three months of continuous travel, that I had the opportunity of making myself acquainted with the geographical, geological, and volcanic and hydro-thermal features of the wonderful country which I shall have the honour of describing to you this evening.

I may point out that, upon my return to England, I had the honour of describing my exploration of the King Country at a meeting held by the Royal Geographical Society during its session of 1885; but on that occasion I could only allude in brief terms to the interesting portion of my travels embracing the Lake Country. At that moment its beautiful and wondrous natural features were as fresh in my memory as they are to-day, and I referred to it then, as I shall now, as the Wonderland of New Zealand. I will endeavour to pourtray it to-night as it appeared before me with its forest-clad mountains, blue lakes, steaming geysers, boiling mud-pools, and countless solfataras and fumaroles, and, above all, with its pink and white terraces of glittering silica rock, which took rank among the many wonders of the world. But, unfortunately, a great part of the attractive picture will become

obliterated when I describe the extraordinary visitation of nature which, almost with the suddenness of a meteor's flight, hurled into chaos the fairest portion of this fair land.

I should here state that for the principal points of information embodied in my description of the effects of the eruption I am indebted for the most part to the able reports furnished to the New Zealand Government by Dr. James Hector, F.R.S., Government Geologist, and by Mr. Percy Smith, F.R.G.S., Assistant Surveyor-General, while for the particulars of the eruption as experienced in various places I have had recourse to the columns of the *New Zealand Herald*, which, by the aid of its efficient reporting staff, placed before the colony a complete description of the catastrophe in a remarkably short space of time.

By the assistance of slides, thrown on the screen by the electric light, some of which have been produced from my own drawings of places comparatively unknown, and by the aid of maps and diagrams, I shall be enabled to explain to you some of the most remarkable physical features of the North Island—from sea level to nearly 10,000 feet above it.

General Configuration of the North Island.

In order that my description may be as clear as possible, I will briefly refer to the general configuration of the North Island.

In outline the island is irregular, and is indented with wide bays and inlets and projecting peninsulas. For the most part, the coast line is high and precipitous. It is about 500 miles long, and 260 miles broad. A bold range of mountains, attaining to an altitude of over 6,000 feet, and of palæozoic formation, runs in a south-westerly and north-easterly direction across its southern portion; while other mountain ranges of various geological formation and age cover a large portion of its surface. It is, however, from the east coast to the centre of the island that I must more particularly direct attention, where large lakes, extensive tablelands, and volcanic cones (some reaching to the region of perpetual snow) constitute the leading natural feature of the country.

Whakari.—The first evidence of volcanic activity in New Zealand is seen when approaching the North Island by the east coast, in the direction of the Bay of Plenty. In this bay, about thirty miles distant from the main shore, is situated Whakari, or White Island, which assumes the form of a cone-shaped mountain with broken sides rising abruptly from the sea to an altitude of 860 feet. The crater, about a mile and a half in circumference, is in the condition of a very active solfatara, whose numerous geysers and boiling springs evolve at all times dense volumes of steam and sulphurous gases, which may be discerned far out at sea. It may be said to begin the line of the active though varying belt of hydro-thermal action which stretches across the North Island, in a north-easterly and south-westerly direction, to the active volcano of Tongariro, with which, according to native tradition, it is said to be connected by a subterranean channel.

Legend of Whakari.—The Maoris assert that when one of their first ancestors, Ngatoroirangi, arrived from the mystic land of Hawaiki in the *Arawa* canoe, and landed at Maketu, he set off across the island with his slave Ngaruhoe, and ascended Tongariro, but finding the summit of the mountain to be covered with snow, and very cold, he shouted out to his sisters, who had tarried at Whakari, to send him some fire, which was conveyed by two *taniwhas*, or evil demons, along the subterranean passage to the chief. Having warmed himself therewith, he turned to comfort his slave, but to his horror he found that the frigid climate had caused him to give up the ghost; so casting the fire into the crater, the flame burst forth, which has continued to this day. To perpetuate this event, Ngatoroirangi named the crater of Tongariro (or the mountain of the south) Ngauruhoe, in honour of his trusty follower, and under that designation it is known to the Maoris of the present day.*

Journey to the Lake Country.

Our journey to the Lake Country began at Tauranga, on the east coast. All the roads leading out of this delightfully-situated town were white with shell and fringed with English trees, whose bright verdure contrasted pleasantly with the picturesque villas, around which all the beauties of the floral world flourished in luxuriance.

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* This legend was related to us by Pehi Hetau Turoa, head chief of the Whanganui tribes, and was subsequently verified in every particular by other chiefs and natives, among the former being Tupia Turoa, of Rotoaira. On the Government maps of the colony the active volcano of Tongariro is named Ngauruhoe, and a smaller mountain adjacent to it as Tongariro. This is an error. The volcanic cone is known to the natives as Tongariro, and its crater as Ngauruhoe. The smaller mountain with its minor crater is Ketetahi.

Beyond the town the country opened out into rolling fern-clad plains, and soon our road passed close to the site of the Gate Pa, renowned as the scene of one of the most terrible repulses ever experienced by British arms.

From this point the land rose rapidly, and in about fourteen miles we ascended to Oropi, at an elevation of over 1,000 feet above the sea. Here looking back over the calm ocean beyond, the view was most enchanting, and was made still more attractive by the cone-shaped form of White Island, whose summit was enveloped in a dense cloud of steam, upon which the sun shone with variegated hues.

At Oropi we entered one of the grandest forests of New Zealand, which lined the track in a green wall of marvellous vegetation for a distance of nearly twenty miles. Here at the highest point of our route, the country rose to an altitude of 1,500 feet, until it descended 200 feet into the Mangorewa gorge, which was formed like a trough in the heart of the mountains. The track again ascended from this point to 200 feet to the opposite crest of the range, when it descended into the great tableland of the lake country.

First Glimpse of the Lake Country.—It was evening when we emerged from the forest, and the road descended rapidly, as if into a basin surrounded by hills and mountains, among which the sharp peaks of Mount Taranera, then dormant in its sleep of ages, were conspicuous in the far off distance by their rugged grandeur. Right beneath us the shining surface of Lake Rotorua caught the last rays of the setting sun, while on its shores the native *whares* of Ohinemutu stood clustered about amidst vapoury clouds of steam, when suddenly even the water flowing by the side of the road bubbled up, hissed and smoked, and as the mists of night mingled with the vapours around, we seemed to have arrived at a region of eternal fire.

Ohinemutu.—We arrived at the township of Ohinemutu at nightfall. It occupies one of the grandest situations in the whole of the lake district. It is built on a slight eminence which overlooks the grand lake beneath. It has a small population composed of Europeans and natives, and it is here where the wonderland of the lake region may be said to begin. For many years it has been visited by thousands of tourists, not only from all parts of Australasia, but from Europe and America, who have been attracted to it for its special features, which are not to be found in any other part of the world. Besides enjoying a delightful and invigorating climate and romantic sylvan scenery, it possesses natural mineral baths of the most luxurious description, and an endless variety of thermal springs which have been proved to be singularly efficacious in the strengthening of the frame and in the cure of cutaneous, rheumatic, spinal, and other diseases which remain unaffected by the best medical skill and appliances.

Physical Features of the Lake Country.

The Lake Country, which forms the principal area of hydro-thermal action in this division of the island, may be said to stretch in a direct line from Lake Rotorua to the northern shore of Lake Taupo, at a distance of about fifty miles, with an average breadth of twenty miles. The altitude of the country within this region averages from 1,000 to over 2,000 feet above the sea. Its general physical features embrace extensive pumice plains, intersected in various directions by high ranges of igneous formation, which are relieved here and there by enormous trachytic cones. Extensive forests of extraordinary luxuriance and beauty clothe the mountains and border the extensive plateaux, while hot lakes, boiling geysers, and thermal springs are dotted far and wide over the country.

Geology.—The rocks forming this division of the country are composed of what is generally known as the acidic or trachytic formation with vast accumulations of volcanic remains, in which scoria, pumice, tufa, silica, and igneous conglomerates are largely combined. These rocks may be traced in all their various stages of formation and transition, from the part they have played in the construction of the colossal mountains to their distribution over the plains by volcanic agency and atmospheric disintegration in the form of the finest dust. All the district bears in a remarkable degree the various distinctive traces of the combined action of fire and water, while the ground for miles around the lakes and springs is covered with silicious and sulphurous deposits, and various other products, the result of the hydro-thermal action which is everywhere observable. Where the decomposition of the volcanic rocks on the surface of the mountain ranges has gone steadily on apparently for ages, and produced a rich soil, the most luxuriant vegetation in the form of primeval forests has its existence, but on the plains where the

pumic deposits have been distributed in strata of great depth, the vegetation is very meagre, and consists principally of low fern, coarse grass, and stunted shrubs.

Character of the Springs.—The geysers, hot springs, boiling mud-pools, solfataras, and fumaroles, and which are known to the natives under the more general terms of *ngawha puia* and *wairaki*—are mostly of the intermittent order, while not a few are very erratic in their movements, subsiding in one place and breaking out in another with wonderful rapidity. The water of some of the springs is as blue and as bright as crystal, in others it is of a greenish tint, while in not a few it assumes a dirty yellow colour. Nearly every one of the principal springs possesses properties peculiar to itself, and mostly all are more or less efficacious in the treatment of rheumatic and nervous complaints and cutaneous and spinal disorders.

Analysis of the Springs.—Upon analysis, the springs are found to contain various chemical ingredients, but in different proportions, according to the quality or properties of the water. Among the principal chemical bodies may be mentioned the chlorides of sodium, potassium, lithium, calcium, and magnesium; the sulphates of soda, lime, potash, magnesia, alumina, and iron; the silicates of soda, lime, and magnesia. In the acids, hydrochloric, sulphuric, and muriatic are found in abundance, while both sulphuretted hydrogen and carbonic acid gas are largely evolved.

Lake Rotorua.—Lake Rotorua, which stands at an altitude of 961 feet above the level of the sea, may be considered as the first link in the chain of thermal action of the Lake Country. This beautiful sheet of water—made doubly attractive by its cone-shaped Island of Mokoia, renowned in Maori tradition and romance—spreads itself out in a circle of twenty-five miles in the centre of a depression bounded in the distance by volcanic hills. It is principally around the shores of this lake that the hydro-thermal action is at present most developed.

Te Ruapeka.—The principal native settlement of this part is situated on a long peninsula, which runs flatly out on a level with the lake. Every part of this strip of land is dotted about and riddled with thermal springs, some of which shoot out of the ground from small apertures, while others assume the form of large steaming pools of various degrees of temperature, from tepid heat to boiling point, and while you may cook your food in one, you may take a delightful bath in another, and get scalded to death in a third.

The Old Pa.—In former times a pa stood at the end of the peninsula, but one stormy night a rumbling noise was heard, then a sound of hissing steam, the trembling earth opened, and the pa with all its people sank bodily into the depths of the lake.

The Whares.—All the whares or huts of the settlement are built after the native fashion of *raupo*, with large recesses in front of the doorways, the woodwork of which is curiously carved. They are clustered promiscuously about the springs and baths, the latter of which the natives use at all times of the day and at all hours of the night—that is to say, if a man feels chilly in bed he gets up and makes for his bath in order to get warm again. Bathing here seems to be a second nature, and the women and girls arrange afternoon bath parties, just as we might assemble our friends at an afternoon tea.

Principal Area of Thermal Action.

The area in the vicinity of Lake Rotorua where the action of the thermal springs is most active, extends from Whakarewarewa on the one side to Te Koutu on the other. The distance between the two points is about three-and-a-half miles, the thermal action extending inland to Ariki Kapakapa, celebrated for its big pools of black boiling mud.

Tikitere.—A short distance from the eastern shore of the lake is Tikitere, a narrow valley, in the centre of which is a boiling water-basin about seventy feet in diameter, and which is surrounded in every direction by hot mud pools and boiling springs.

Lake Rotoiti.—Close to Tikitere is Lake Rotoiti, whose deep bays and jutting headlands impart to it a very beautiful appearance. Hot springs occur on its southern shore.

Lakes Rotorua and Rotoehu.—These are warm lakes of picturesque formation, and the waters of both are rendered of a greyish opaque colour by the action of the subaqueous springs.

Whakarewarewa.—About two miles to the south-west of the lake is Whakarewarewa, a native settlement surrounded by a wide area of thermal action. One of the largest geysers, here called by the natives Waikite, rises from a cone of silicious rock nearly fifty feet high, and over a hundred feet in diameter. In its most active moments it throws up a column of boiling water to a height of sixty feet.

Many of the numerous springs here possess great curative properties, while the mud-pools and fumaroles are amongst the largest and most active in the district.

FROM ROTORUA TO LAKE TARAWERA.

At a distance of about seven miles from Lake Rotorua is Lake Tarawera, around which the most extensive and varied thermal phenomena of the district are to be found. To reach this point, the route we travelled was then one of the most beautiful in the world.

The Tikitapu Forest.—One of its principal features was the Tikitapu forest, one of the grandest gardens of primeval vegetation in the North Island. Whilst the trees here attained to a colossal size, and the shrubs to a marvellous luxuriance, many of the rarest and most beautiful ferns of the country formed a dense undergrowth which covered every foot of ground like a variegated carpet. Countless orchids, and lichens and creeping plants, struggled to the tops of the tallest trees, which spread their giant branches over the roadway in an arched canopy of vivid green, and appeared to touch the sky as they mounted upwards to the very summits of the steep mountains which rose on every side beneath the thick, impenetrable growth which covered their rugged slopes without a single break.

Lakes Tikitapu and Rotokakahi.—Emerging from the deep gloom of this forest, the azure waters of Tikitapu, or the Blue Lake, came suddenly before our view with the most enchanting effect. It was only about half a mile long, but for calm picturesque beauty it was one of the most attractive sights of this wondrous region. A narrow saddle falling from a range of bold hills divided it from Rotokakahi, or the Green Lake.

Te Wairoa.—At a short distance from Rotokakahi was situated Te Wairoa, the native settlement, which was overwhelmed by the terrible catastrophe. It was placed in a deep gorge, and hemmed in by rugged ranges which seemed to serve as a gate to the wonders of the lakes beyond. The Wairoa river wound through it, and flowing in the direction of Lake Tarawera, leapt over a precipice of nearly a hundred feet in the form of a foaming cascade, about which the greenest of ferns and mosses grew in wonderful luxuriance. The settlement consisted of clusters of native huts, surrounded by small gardens and deep thickets of sweet briars. There were in addition two capital hotels for the convenience of the tourists, a public hall and Maori Temple, and an Episcopalian Church and public school.

The Native Hapu or Tribal Family.—The natives belonged to the Tohourangi *hapu*, and numbered about 250. They were a robust and healthy people, and among them were some very fine specimens of the noble savage. In fact, from time immemorial, the men of these parts have been noted for their giant physique. At one time they were among the most warlike of the great Arawa division of the race.

Lake Tarawera.—We gained Lake Tarawera through the Waituwhera gorge, and embarked at a narrow inlet of the lake. Our voyage was accomplished in a whaleboat, manned by stalwart Maories. As we glided onward, all the varied beauties of Tarawera unfolded themselves with magical effect before the view. The lake, which was seven miles long, by about five miles broad, was evidently at some period the centre of a widely extended volcanic action, as evidenced by the volcanic rocks which lined its shores, as well as by the rugged peaks which added grandeur to its scenery. On every side of the lake bold mountains with conical peaks and serrated ridges, rose up from the very edge of the water, covered to the summits with a rich growth of giant-like vegetation. Picturesque headlands jutted out into the water, deep bays, broad valleys, and weird gorges came before the view at every turn, and the scenery was so wild, so grand, and so varied, that one hardly knew which part of it to admire the most.

Mount Tarawera.—Right in front of our course Mount Tarawera (which I shall hereafter more fully describe as the central point of the eruption) towered in the form of a colossal truncated cone, with steep sloping sides, tinted with red oxide of iron and shiniug obsidian, which made it look as if it were just cooling from the terrific heat of volcanic fires.

Te Ariki.—Passing beneath the shadow of Mount Tarawera, we entered Te Ariki, a wide inlet at the southern end of the lake. Here the hills and valleys spread themselves out in a splendid amphitheatre of enchanting scenery, while clouds of steam rising in the distance told us that we were fast approaching the wonders of Rotomahana.

Lake Rotomahana.—Lake Rotomahana, before its destruction by the eruption, was connected with Lake Tarawera by a small stream named Kaiwaka. It stood at the elevation of a little over 1,000 feet above the level of the sea; it was one of the smallest of the group, and was about a mile long by a

quarter of a mile wide. It was, however, grandly picturesque, not only by reason of the unique features presented by the Pink and White Terraces, but likewise on account of its steaming shores, with their countless hydro-thermal phenomena, as well as by the bold rugged scenery which surrounded it on every side. The whole basin of the lake was the seat of a vast thermal action, which spread out to the base of the conical hills which encircled it, and beyond which the towering mountains, as they rose thousands of feet in height, appeared to have been heated and twisted by the terrific action of volcanic fire, while the deep gorges and wild ravines seemed to have formed at some period or another the channels for the streams of molten lava. Everywhere around one could trace the wondrous working of fire and water, in such a way as to prove beyond question that there was a time when the whole region surrounding this curious lake was the scene of a widely extended volcanic action. The term *Rotomahana* in the Maori language literally means "hot lake," and its water, of an opaque green, was at most times covered with air bubbles, sent up from the hot springs from beneath its surface. The mean temperature of the water was about 80° Fahr., but in the vicinity of the hot springs it rose frequently to over 112° Fahr. It was on the shores of this lake, embosomed in the midst of the most enchanting scenery, that boiling geysers sent their silica-charged waters over the delicate fretwork of the Pink and White Terraces.

The White Terrace.—The most remarkable of these structures was the White Terrace, or Te Tarata, as it was called by the Maoris. I will describe this terrace as it appeared in all its singular beauty before me, and in words which were written just after I had seen it, and when my mind was filled with the pleasant thoughts it inspired. This description, I my add, was not penned in a luxurious arm chair in a comfortable hotel under the soothing influence of a cheroot and a bottle of Cliquot champagne, but in the dim interior of a Maori hut, where a dozen natives lay around me smoking, coughing, wheezing and snoring, and by no other light than that afforded by a "slush lamp," which means a dirty strip of rag floating in melted pork fat.

The White Terrace was situated on the southern shore of the lake, and within a region of great hydro-thermal activity. We ascended to the summit of a low hill which looked down upon Lake Rotomahana, whose green-tinted waters, surrounded by clouds of steam, shone with an emerald-like brightness in the sunlight, while immediately in front of us the White Terrace, or famed Te Tarata, burst upon the view like a glittering heap of frozen snow just fresh from heaven. We were still some hundreds of yards from it, and although at the first glance fair Te Tarata looked chaste and beautiful enough beneath the golden light, it appeared as if her proportions were somewhat cramped and stunted, and I began mentally to question the wisdom of nature in not placing the wondrous monument of her handiwork higher up on the slope of the mountain which decked the delicate outline of the terrace in a variegated fringe of green. Presently we descended the hill, and, after picking our way through a small scrub riddled with boiling springs, we suddenly came into the open, when, as if by the magic touch of the enchanter's wand, the whole scene changed, and Te Tarata, gleaming still whiter in the sun, rose in grand yet delicate proportions high above our heads. The white ethereal vapour wreathed its summit like a graceful summer cloud; the rugged hill which held Te Tarata as it were in its arms stood out in bold relief against the clear blue sky; and nature, true to the inspired genius of her marvellous creative power, stood revealed in all her pristine loveliness.

Casting the eye around, it seemed as if nature had created the wonders of the lakes and mountains of this fair region, with all the marvels of fire and water, after the most enchanting design of earthly beauty, and had then gone into the realms of fable and romance, and thrown in a piece of fairyland to complete the picture; or as if the gods, when they called these sublime works into being, had fashioned Te Tarata as a throne to recline upon whilst they gazed in admiration upon the beauties of their wondrous creations.

As we looked upward, the outline of the terrace assumed a semicircular form, which spread out at its base in a graceful curve of about 800 feet, as it sloped in gradations of broad terraces, gently down from its summit, in a distance of nearly 1,000 feet, to the margin of the lake, above which it rose to a perpendicular height of nearly 100 feet. In this way it presented a superficial area of white silica rock of nearly 10 acres.

Broad, flat, rounded steps of pure white silica rose tier above tier, white and smooth as Parian marble, and above them terrace after terrace mounted upward, rounded and

semicircular in form. All were formed out of a delicate tracery of silica, which appeared like lacework congealed into alabaster of the purest hue. Crystal pools shaped as if to resemble shells and leaves, and filled to their brims with water blue and shining as liquid turquoise, charmed the eye as we mounted to every step, while around the edges the bright crystals of silica formed encrustrations which made them appear as if set in a margin of miniature pearls.

Every successive terrace seemed to spring up in grander proportions from the one immediately below it, not in formal angular-shaped steps, but in flat-topped elevations with rounded edges and sweeping curves, from which the wet glittering silica hung in the shape of sparkling stalactites, which interlacing themselves, and mingling together, formed a delicate and almost transparent fringe, which looked like a fantastic network of icicles, so exquisitely beautiful in appearance, and so delicately formed as to appear as if fashioned by the magic touch of a fairy hand.

The Crater.—The crater of Te Tarata was formed of a milk-white circular basin of over 220 feet in diameter, and out of which a boiling geyser burst forth from a funnel-shaped aperture, the orifice of which was about twelve feet in diameter. Here the hissing liquid in a constant state of ebullition bubbled and seethed in the form of a boiling fountain, while a waving cloud of steam floated constantly upwards as the blue silica-charged waters flowed gently over the terraced platforms beneath.

The Pink Terrace.—It was on the opposite shore of the lake, backed by a sloping hill, and surrounded by verdure that the Pink Terrace (Te Otukapurangi, or "The Fountain of the Clouded Sky" of the natives), rose from the warm green waters of the lake.

The formation of the Pink Terrace differed somewhat from that of the White Terrace. It was semicircular in general outline, but the successive terraces of which it was built up rose more abruptly from the lake, while they were higher above each other and more massive in appearance. Hence the deposits of silica had assumed the same general formation, and each terrace was gracefully and marvellously shaped with rounded edges, which swept about in waving curves as if they had been fashioned after one grand and unique design. Hence the deposits or layers of silica rock did not assume, like those of Te Tarata, a wonderful combination of delicate lacework around the edges of the terraces, but the silicious laminations appeared thinner and not unlike the corrugated surface of pink satin rep. On the wide platform of each succeeding terrace there were flat irregular shaped tablets set in a network of silica cords, while pools or salmon-coloured basins, all exquisitely and quaintly formed, with curving shell-shaped margins, were resplendent with water of an opaline blue.

The Crater.—At the summit of the terrace was a steaming cauldron formed by a round alabaster-like basin, about 100 feet in diameter. Here the deep blue water, within a few degrees of boiling point, lay without a ripple upon its surface, beneath which the silicious deposits which encrusted the sides of the crater assumed all the marvellous and fantastic designs of a coral grove.

The Volcanic Eruption.

It was this beautiful region which was last year visited by a catastrophe which must take rank as one of the most remarkable volcanic eruptions of modern times. Up to within an hour of the time when Mount Tarawera burst forth into renewed activity, no special sign had been observed of the approaching calamity in the vicinity of the outburst. The whole face of the country seemed as quiescent as it had been for centuries past. During the time which New Zealand has been known to Europeans there has been no change of any moment in any of the active volcanic areas of the country. It was quite common for a spring to stop flowing at one place and re-appear at another, but the changes were only trifling and local. Furthermore, no tradition of the Maoris spoke of any violent eruption. The native traditions record with much detail that the ancestors of the race, when they arrived from Hawaiki in their canoes, found the hot springs and active volcanic vents much as they are to-day. In 1855, at the time of the earthquake at Wellington, a considerable eruption of ashes is said to have occurred at Ketetahi, a still active crater on the Tongariro group. In 1857, Tongariro itself ejected cinders and ashes during several weeks, and on the 6th July, 1881, the mountain was remarkably active. At this time flames were seen issuing from the crater, and violent explosions were heard as far as the east coast. It is probable that the eruptions of Tongariro, within the traditions of the Maoris, were more more active at one time

than now, as they still relate that it was considered by them as a sign from their Atuas or gods to begin war. The only eruption in the Hot Lake District which caused a loss of life is said to have occurred about 120 years ago, when the site of Ohinemutapapa, called Uriuku, was submerged in a part of the Rotorua lake, which was at that time boiling. On that occasion about thirty natives were scalded to death.

Up to the moment of the outbreak there were no signs whatever that Mount Tarawera, the central point of the eruption, was about to awaken into active life. Since time immemorial this grand volcanic cone had been regarded by the Maories as a sacred mountain, and it had become renowned in song and legend, and among the tales connected with it, a monster *taniwha*, or fabulous green dragon, gifted with cannibal proclivities, was said to haunt it, while in its extinct craters, the bones of countless warrior chiefs of the Arawa tribe lay guarded by the mystic *tapu*.

The Focus of Eruption.—I have before alluded to Mount Tarawera as rising in the form of a colossal truncated cone at the southern end of Lake Tarawera. Its altitude is over 3,600 feet above the level of the sea, and the whole mountain group may be classed as one of the principal cone formations of the North Island. It possesses three craters, named respectively Tarawera, Ruawahina, and Wahanga, and all its physical characteristics would tend to prove that at some remote period it formed the principal centre of volcanic action of this region. It had, apparently, never been a wide centre of upheaval, but partook more of the formation of Tongariro, being built up principally of trachyitic rock, lava ridges, and volcanic ejecta in the form of tufa, scoria, pumice, igneous conglomerates, and deposits of obsidian, the latter product being larger upon it than upon any other mountain of its class in the district. Before the eruption, a rich vegetation clothed its base, and above this the steep shelving sides of the cone-like mass rose to the rugged craters whose serrated edges assumed the form of a spiked crown. This mountain was the principal focus of eruption.

Beyond Mount Tarawera, in a distance of about six miles, the country stretched away to the southern shore of Lake Rotomahana in a series of undulating cone-shaped hills, interspersed with deep valleys and rock-bound ravines. It was here that boiling geysers sent their silica-charged waters over quaintly formed terraces of sinter rock. Every bend of the shore and jutting point of land was alive with its cluster of fumaroles; every valley sent up its cloud of steam, and echoed to its fountains of heated waters, while the quaking soil and smoking hills sent forth their jets of vapour from a thousand fissures.

It was between these two points that the terrible visitation declared itself. I will first describe its effect at a distance, and the leading features of the outbreak at the scene of the eruption, and how settlements were wrecked, and human beings destroyed.

Distant Effects.—The eruption occurred at about 10 minutes past 2 o'clock a.m., the 10th June. At this season it was mid-winter at the Antipodes, and the summits of the mountains of the Lake Country were covered with snow, the wind blew strongly from the south—the coldest quarter—and the whole island was wrapped in the darkness of night. Altogether the active eruption lasted six hours. During that time a sound, resembling salvoes of distant artillery, was heard at Auckland, 150 miles away. At Tauranga, on the east coast, nearly 60 miles distant from Tarawera, strong earth tremors were felt, a great glare and sudden illumination was seen in the southern sky, and showers of vocanic dust fell for miles over the country.

Effect at Lake Rotorna.—At Lake Rotorna, at about twelve miles distant from the seat of the outbreak, there were heavy earth tremors at 2.10 a.m., then a fearful roar, when it was seen that Mount Tarawera had suddenly become active, belching out fire, smoke, and ashes, to a great height. A dense mass of ashes poured down at 4 o'clock, accompanied by a suffocating smell of sulphurous gases. An immense black cloud which rose above the mountain was densely charged with electricity, with this came loud peals of thunder, roaring of craters, and continual shaking of the earth. Many of the springs and geysers in the neighbourhood betokened increased activity, and some rose suddenly in temperature, new fumaroles sprang into existence, the waters of Lake Rotorna rose and fell, while the ground in many places was fractured by small fissures The heavens all around this region presented a magnificent spectacle from the reflection of the volcanic fires. This terrible visitation naturally struck terror into the inhabitants, many of whom fled, half-dressed, from their homes, while the natives clustered about in groups frightened to death.

Effect at Whakarewarewa.—The effect at

this place is described by an Australian tourist. At about half-past two a.m. a sharp concussion occurred; the shocks were very heavy, and very regular and frequent. Prior to half-past two the night was quiet, calm, and clear, but at three o'clock there was intense darkness, and then came the explosions, which appeared like immense sheets of flame. The lightning commenced radiating in all directions. In the zenith the light appeared as if little grains of powder were being let off, and there was a pall of dense smoke over all. Dust fell, covering the whole place, and it was so fine that it affected the breathing. There was a very heavy noise, and its roaring was like that going through a tunnel, and the earth was in a continuous tremor, like the vibration of a railway carriage. The tourist asked an elderly Maori if what was going on often happened. The native replied, "No, not at all; too much earthquake."

Effect on the Tikitapu Forest.—This splendid forest, which I have before described as one of the grandest gardens of New Zealand, on the night of the eruption became a scene of weird desolation. The storm of wind and the showers of mud, stones, and sand, swept over the valley, tearing up gigantic trees by the roots, snapping off giant limbs like twigs, while the heated matter caused many of the trees to ignite. So great, in fact, was the desolation caused, that the whole forest appeared as if it had been swept by a terrific cyclone.

First Effect at Wairoa.—It was, however, at Wairoa that the effects and results of the catastrophe were seen and felt with a terrible reality. I have alluded to this place before as the native settlement on the shore of Lake Tarawera, with its clusters of huts embosomed amidst thickets of sweet briar, with its heathen temple and Episcopalian Church, and its population of one or two European families who had gained the respect and esteem of the native inhabitants. This romantic and delightful spot, then with its small community of Colonials and Maoris, and where the light of Christianity had just begun to dispel the darkness of heathenism, met, with its population, a disastrous fate on the eventful night. Here a few moments after the first outbreak everything—buildings, trees, human beings, were stricken down and buried in hot ashes and volcanic mud.

About 20 minutes to 1 o'clock a.m., on the morning of the 10th, the whole place began to shake, and shocks of earthquake were continuous for nearly an hour before the eruption broke out. When that was first seen, it was like a small cloud over the mountain, pierced by flashes of lightning of great brilliancy. Then suddenly the outburst came. Apparently Mount Tarawera, now only eight miles distant, had three craters which belched forth flames of fire nearly a thousand feet high. There seemed to be a continuous shower of balls of fire for miles around, great bodies of solid matter were hurled up amidst showers of sparks and terrific detonations, roaring noises from the craters, and the loud hissing of columns of steam which mounted thousands of feet into the air with red tongues of flame and flashing lightning. Thunder rolled above, and there were loud crashing reports as enormous stones fell to the ground, and the giant trees snapped like matchwood beneath their weight. The pale vivid glare of the electric fire shot through the lurid volcanic flames and illumined in a marvellous way the under portion of a dense black cloud which hung like a pall over the heavens, while showers of heated stones, volcanic mud and dust, mingling with heavy rain driven furiously onward by the wind, fell far and wide over the country, beating down and covering up everything.

The Doom of Wairoa.—At this awe-inspiring moment came the doom of Wairoa. From the commencement of the eruption the stones and ashes had done the settlement great damage; but suddenly, when the outbreak was at its culminating point, a tremendous shower of volcanic mud and stones, and ashes, falling with appalling force, crushed in the frail wooden houses and Maori huts, and buried many of the inhabitants beneath a stratum of volcanic *débris* nearly ten feet thick.

The victims of this sad calamity, either European or native, had very little time to prepare for their sad fate, but those of them who survived acted with much courage, and made every possible effort to rescue their neighbours, while those who perished met death with extraordinary coolness and resignation.

The Terrible Deaths and Remarkable Escapes.—There were some terrible deaths and remarkable escapes. Most of the natives, numbering nearly a hundred, were literally buried alive. Among the Europeans, the family of Mr. Hazard, the schoolmaster, experienced great loss and trials. Mr. Hazard himself, with three of his children, was killed in his own home during the catastrophe; Mrs.

Hazard was pinned to the floor by the roof falling, with a child in her arms and two children by her side. She was afterwards rescued, but the child at her breast was killed. Her two elder daughters escaped into another portion of the house, and were saved. One of these young ladies, Miss Clara, when the volcano was dealing death and desolation around, and the shower of mud and ashes were falling upon the roof, assembled her parents and brothers and sisters in the parlour, and sat down at the organ and played and sang hymns.

A Mr. Bainbridge, from England, a visitor to the lakes, called a prayer meeting amidst the perils of the imminent calamity, and after preparing himself and others for the future life, was buried by the falling matter a few minutes afterwards beneath the verandah of his hotel.

Four days after the destruction of Wairoa, a Maori *Ariki* or priest, named Tu Huto, said to be over a hundred years old, was discovered half buried in mud, under the corner of a hut where he had lain for 104 hours. Singular to relate, he was none the worse for his partial burial, and ate a hearty meal of pork and potatoes as soon as he was rescued. It was believed by many of the Maoris that the old man, by his evil machinations, had brought about the eruption, and those who survived the visitation thanked their stars that Tu Hoto had perished. It is, however, clear that the Maori wizard did not look upon the eruption in the same light.

Destruction of Other Settlements.—Most of the other settlements around Lake Tarawera were destroyed, and at Moura, near Lake Rotomahana, over forty natives lost their lives, together with the chief Hiheta, Kaipara.

A Modern Pompeii.—But it was the small settlement of Te Ariki which will take rank in the history of New Zealand as a modern Pompeii on a small scale. It was the home of about forty-five natives of the Ngatitaoi, a *hapu* or tribal family of the Tuhurangi tribe, and was situated close to the very slopes of Mount Tarawera, where the conical hills forming its steaming flanks sloped gently down to the junction of the hot waters of the Kaiwaka stream as it flowed from Lake Rotomahana into Lake Tarawera, forming the connecting link between the two bodies of water. A few picturesque huts scattered about on grassy slopes, one or two old canoes upon the shore, and a *tapued* or sacred rock not far distant, upon which visitors were invited to place monied offerings to appease the wrath of the deities before visiting the Terraces, were the principal features of Te Ariki. On the night of the eruption no lava streams wrapped in their fiery embrace the sleepers of this primitive settlement to conserve their remains for future generations to marvel at, but Te Ariki was blown into the air by one terrific blast, with all its people, and with them their brave chief Rangihewea.

Rangihewea.—I was much concerned at hearing of the death of this aged man, because I had written of him elsewhere, and he was one of my companions on my journey across Lake Tarawera to the Terraces. He was a tall, splendidly built savage of the old Maori type, with beautifully defined features, which were elaborately tattooed up to the very roots of his hair. As he crouched at my feet in the boat he related to us, in a singularly quaint way, many legends of the lake, and how the bones of many generations of his race had been placed on the top of Mount Tarawera, and likewise how sometimes, when the moon was high, the spirits of the chiefs would descend from the mountain, and getting into a phantom canoe, commanded by his ancestor Te Aorangi—The Light of Heaven—in feathers and war paint, would speed over the lake, while the taniwha, or evil demon of the mountain, stirred up the waters. He related also some of his exploits during the war, when he had fought on the side of the English, and when at the end of our journey his tattooed features seemed to be convulsed just a little as we bade the last farewell, I never imagined that this savage hero, who was verging on eighty summers, would end his gallant career on this earth by being blown into eternity by a volcanic eruption.

After Effects of the Eruption.

By six o'clock a.m. the violence of the eruption had virtually ceased. When daylight broke, it was then seen that the whole country within the area affected by the outbreak had undergone a remarkable change, while many of its physical characteristics were completely changed. One of the most remarkable features were the extensive deposits of pumice sand, which covered the district over an area of many hundred square miles in a coating as white as snow, and which completely smothered the vegetation, and in many parts obscured it from view altogether. In some places this sand deposit, especially near the centre of eruption, formed extensive hills, while in other instances it was

carried by the atmospherical influences, so far as to be deposited in the finest form 150 miles distant. Another sand deposit of a peculiar character, and of a greyish colour, fell in an almost pasty condition, while enormous masses of rock were distributed far and wide. These latter ejecta were not sent forth in a molten state, but were formed principally of the crude rock peculiar to the geological formation of the country.

Focus of Eruption.—The focus of eruption was from 7 to 10 miles in a north-east to south-west direction, from Mount Tarawera to Okaro Lake. Here a singular change had occurred. Along the edge of the Tarawera mountain system seven distinct conical points were seen giving off steam, which, with solid matter, was discharged to a height of 200 to 500 feet. One of the most remarkable phenomena in this spot was found in the formation of an enormous fissure, which struck across the eastern side of the mountain. This rent did not appear to be a slip from the mountain side, but as if a portion of the mountain measuring 2,000 feet by 500 feet, and 300 feet deep, had been blown out, leaving a rugged, rocky chasm, from which steam issued in rapidly succeeding puffs. Near to this singular abyss were several powerful geysers throwing up great volumes of boiling water, with stones and mud, to a height of 600 to 800 feet.

Transformation of Lake Rotomahana.—The most remarkable feature in the same line of volcanic action was the extraordinary convulsion which had changed the whole conformation of the country around Rotomahana, and had transformed the hot green lake with its marvellous terraces into a roaring crater, from which rose a column of steam nearly a mile and a quarter in diameter, and which ascended in the form of a cumulus cloud to a height of over 13,000 feet, and nearly a mile in width. Thus in the brief space of four hours this delightful fairyland had been turned into a condition suggestive of a scene in Dante's "Inferno." The spot where the White Terrace formerly stood was occupied by a crater, forming a kind of horse-shoe bay, and from this a vast column of steam rose and mingled with the general mass. The site of the Pink Terrace, once on the western shore of the lake, now stood a quarter of a mile from the margin of the present crater, in the midst of a mass of boiling mud black and brown in colour, with seething pools of steaming water or liquid mud, which was sometimes cast up into fumaroles, ejecting steam and vomiting forth stones and mud, with a noise like the roar of innumerable steam-engines.

Theories on the Eruption.

There have of course been several theories started as to the origin of the eruption, but in order to draw reasonable deductions which may account in any way for the occurrence, we must be guided by the knowledge which science has presented to us, from facts derived from the examination of the causes and effects which have been produced by similar visitations.

Dr. Hector's Theory.—Dr. Hector, whose reputation as a geologist should secure to his opinion great consideration in dealing with a question of this kind, points out, in his report to the New Zealand Government, that Dr. von Hochstetter classed Mount Tarawera with the Horo Horo mountain—a flat-topped elevation about twenty miles to the westward of the former mountain—as being part of his older or submarine volcanic series, although he likewise draws attention to the fact that Hochstetter mapped down Mount Tarawera as belonging to the recent trachytic series of volcanoes. Whether Mount Horo Horo had a submarine origin is a point I will not venture to discuss here, but that Mount Tarawera had no such origin, I think there can be little doubt, since every geological characteristic of the mountain would lead to the supposition that its whole mountain system must have been at the height of its greatest volcanic activity about the same geological epoch as the Paeroa mountain, about fifteen miles southward the Kataramea range, south of Lake Taupo, and ages after the extinction of the great crater now forming the basin of Lake Taupo, and long subsequent to the active existence of Mount Ruapehu. The mountain is therefore undoubtedly of—geologically speaking—recent volcanic origin; and admitting this view, Dr. Hector considers that it is not unreasonable to assume that the still imperfectly cooled mass of lava in the heart of this volcanic mountain has given rise to the long-continued — historically speaking — solfatara action at high temperature that created the attractive wonder of Lake Rotomahana.

Individually, I cannot bring my mind altogether to coincide with the theory of a still imperfectly cooled mass of lava existing in the heart of Mount Tarawera.

It should be remembered, to give an idea of the stupendous proportions that such a mass of heated matter would be likely to assume,

that the highest point of the mountain is 2,600 feet above its base, which, roughly estimated, cannot be less than some fifteen miles in circumference. In regard to position, its base is twice as near to Lake Tarawera as it is to Lake Rotomahana, or about two and a-half miles from the former, and four and a-half miles from the latter. If, therefore, a body of partially cooled lava, of a size that such a mountain would undoubtedly give rise to, actually existed in the way suggested by Dr. Hector, it is only reasonable to suppose that, with its natural subterranean ramifications, its heat-giving influence would be felt in a double degree in Lake Tarawera, which should consequently be a warm if not a hot lake, instead of possessing water of the average normal degree of temperature.

Again, if the partially cooled lava deposit in question were there, by what hypothesis could it have remained undisturbed by the terrific heat evidently engendered by the eruption, and not have been transformed into a state of molten fluidity, and ejected by the violent forces in the form of lava streams, volcanic bombs, and *lapelli* or small fragments, in the latter of which condition similar ejectments of lava are to be found at Tongariro Ruapehu, and other volcanic centres of the island.

Now it should here be noted that, after the eruption, it was proved by a careful examination, that there had been no lava outflows or ejectments of lava in any form, and that the masses of stone, some weighing over a ton in weight, hurled from the crater, all possessed the distinctive characteristics of the crude rocks of the district, that is to say, they had undergone no igneous change by the eruption.

Without putting in question the volcanic mountains of the island as having their origin in a previous igneous condition of New Zealand, it is my belief that the recent eruption of Mount Tarawera was quite separate and distinct from any condition of the kind, and that it had no relation to similar fiery volcanic eruptions which must have been characteristic of the older eruptions of these particular mountain systems, as when, for instance, the primary centre of volcanic activity was centered in the great crater of Lake Taupo, or even when Mount Ruapehu poured out its streams of incandescent lava, and which may now be seen cooled in the form of colossal deposits of adamantine-like rock running down for miles from the summit of the mountain, and as distinct in their igneous formation as if they had been cast out from the volcanic vents but yesterday. It was at this period, no doubt, that the lava deposits played their part in heating the rocks and waters around the region of volcanic action, but all these igneous deposits of an age long past, have, in my opinion, long since cooled down to enormous depths, at least so far as their primary incandescent condition is concerned, and that they do not now act in any way upon what may be termed—when the enormous thickness of the earth's crust is taken into consideration—the mere surface waters of the island.

But taking even again the dimensions of Mount Tarawera into consideration, if a mass of lava lay deposited in the heart of the mountain, presumably since its last eruption, it seems to me that it would by every reasonable scientific deduction have had time to cool beyond a stage which, according to Dr. Hector's theory, may be exemplified by dropping a little water on a surface sufficiently heated to cause the liquid to be immediately converted into steam.

In the first instance we have the reliable authority of native tradition that no eruption has occurred within the memory of the race since its first coming to the island, which may be roughly estimated at about 1,500 years ago. Moreover the lower slopes of the mountain were clothed with forests of enormous trees, many of which would no doubt count over a thousand years of growth. But let me advance a further opinion upon the long inactivity of the mountain.

During the eruption the craters of Mount Tarawera sent forth showers of stones, masses of rock, and other destructive matter, in a sweeping radius of many miles, but the Terraces only stood about three miles distant from the base of the mountain, and in order further to substantiate what I believe to be the long quiescent stage of Mount Tarawera, we will try and work out an approximate age for the terraces.

On both of these marvellous structures were smooth alabaster-like tablets, and by the aid of a pencil one could write upon them as easily as upon a slate, the moment a mark was made, the silica-charged water poured over it, and it became indelible. I saw the names of Europeans written upon these slabs, with dates of the day, month, and year affixed, going back as long as twenty-five years ago, but so gradual and delicate was the process of obliteration that they appeared as if they had only been written the day before, and had been covered with a coating resembling the

thinnest and most transparent glass. I calculated that under this same process it would take nature nearly 100 years to obliterate one of these names.

I have told you that the White Terrace rose to nearly 100 feet above the lake, that it stretched out in the form of an open fan in a distance of 1,000 feet to the water-line, and that it comprised a superficial area of about ten acres of silica rock. Now take the clear blue water, as it flows from its boiling geyser from terrace to terrace, and remember that, passing over a given surface, the amount of silica it held in solution would take by its slow process of deposition 100 years to obliterate a pencil mark; and then, if you like, double, treble, and quadruple its amount of silica, and even then, just think how many countless ages must have passed away since the geyser of the White Terrace—originating probably at first in the form of a small heated spring from a vent at the bottom of the escarpment of the big mountain—which seemed to grasp the fair terrace in its arms, gradually developed into a boiling fountain until it built up the wondrous structure into its grand and beautiful proportions. Then turn to Mount Tarawera, whose beetling brow overhung this delicate, unique gem of nature, and ask yourself whether, during the long period required for the construction of the White Terrace and that of its pink sister, it could have sent forth its showers of ponderous stones and heated matter without utterly destroying these fragile monuments.

My opinion is that the volcanic action, as exemplified in the present hydrothermal activity of the island, is confined to a comparatively shallow depth below the surface of the country when compared with that which no doubt had its existence at the time when the great volcanic centres of the island were in a condition of maximum activity, and since which time the various stages of volcanic forces, as exemplified within the radius of the various points of such activity, have gradually died out.

The volcanic phenomenon, as exemplified in the eruption of Mount Tarawera, was, therefore, to my mind, in its general character, purely hydrothermal in character — in the sense in which that term may be applied in contradistinction to the fiery or lava eruptions which had their existence at a later period—and I believe it was caused primarily by the chemical actions and reactions which have no doubt, for a long period of time, been active in the immediate area of Lake Rotomahana.

In order more fully to explain the chemical actions and reactions referred to, let me point out that it is well known that the metallic bases of the alkalies and earth, such as potassium, calcium, and other bodies, the moment they come in contact with water, are decomposed with an evolution of intense heat, and this is sufficient to heat rocks, convert water into steam, and give rise, by mutual decompositions, to the formation of carbonic acid, sulphuretted hydrogen, and other gases. Now where such metallic bases exist (and I have referred to the existence of them when dealing with the analysis of the springs), water finding its way to them through fissures and by other means, unites and causes the phenomena of hydrothermal action and solfataric action.

I believe we know too little of the hydrochemical action, as developed by the surface water of the earth, and equally so of the electrical operations which are going forward in various geological formations, not only in New Zealand but in other parts of the earth; and not sufficient importance has hitherto been attached to their agencies—and more especially to the latter—by scientists when dealing with volcanic action as much in relation to its igneous character, as exemplified in the old eruptive stages, as well as in the reference to the hydrothermal phenomena, both in past and present periods.

Be that, however, as it may, there can be no doubt whatever that a widely extended hydrothermal activity, caused in my opinion purely by the process of chemical action and reaction before alluded to, had been working slowly but surely for ages past, not only around the shores of Rotomahana, but deep down below and under the very bottom of the lake.

A Superheated Region.—Let me point out that Lake Rotomahana was situated within an area of depression, and around its eastern shore there stretched, in the direction of Mount Tarawera, a wide expanse, surrounded by low steaming hills of volcanic formation. Every part of this area of depression was literally permeated with hydrothermal energy, and it appeared to me at once, when I saw it, to be in a condition of gradual subsidence. In the central portion the steaming green water from an inlet of the lake spread over a kind of dismal swamp, dotted with miniature islands, where coiling jets of vapour mingled with stunted shrubs, while dank rushes, which spread out like a green carpet everywhere,

formed the abode of innumerable wildfowl. In this weird locality, on every side, the soil was soddened by heated water, and literally riddled with steaming fumaroles, and when I put my thermometer only an inch beneath the light green moss which covered the ground, it went up immediately several degrees over 212°, or boiling point. It was only necessary to push a stick a foot beneath the surface, and a steam jet, like one suddenly evolved from the safety valve of an engine, would spring up, and send its stream of vapour several feet into the air. It was impossible to stand in one spot for more than about a minute at a time, as the heat would pass through the thickest boots. There were miniature hot lakes here and there, filled with water of the colour of green sealing-wax, hot and smoking, with a fœtid sulphurous smell; and there were large seething and boiling pools of black, brown, and greyish mud, which threw up their slimy matter with a curious gurgling sound as they sent forth stifling fumes of noxious gases. There were mud cones dotted around, assuming, in a remarkable degree, the symmetrical form of cone-shaped volcanoes as they vomited forth steam from minute craters at their pointed summits; there were large solfataras, or orifices, from which sulphurous vapours, hot mud, and steam were emitted; spluttering sulphur jets which sent forth highly charged sulphurous fumes, which, condensing when coming in contact with the cool air, deposited the bright yellow mineral around in the form of glittering crystals. Here, too, were deep gorges, which echoed to their fountains of heated waters, while their rugged sides of volcanic rock sent forth hissing jets of steam from innumerable fissures. Enormous geysers issuing from boiling cauldrons, threw their water high into the air amid coiling clouds of steam, to fall again into the overflowing basins below, whence they rolled in hot streams to the lake. Powerful transparent jets of superheated steam burst furiously forth with a deafening screeching noise, as if eager to escape from their rock-bound prison house and blow up the surrounding country, while the terrific pressure acting in some way upon the rocks below, made them send forth "thuds" like the beating of innumerable steam-hammers. The soil was everywhere covered with thick deposits of silicious sinter, sulphurous encrustations, pumice, obsidian, scoria, and other volcanic and hydrothermal products; and with its steaming fœtid atmosphere, fierce heat, and shrieking sounds, no place that I had ever beheld was more suggestive of Pandemonium.

SUPPOSED CAUSE OF THE ERUPTION.

It was this superheated region which, in my opinion, suddenly subsided and caused the primary eruption. Here, no doubt, for a long period of time, as I have before suggested, the chemical action and reaction alluded to had been in progress, causing a vast exhaustion or subsidence, as likewise under the bottom of the lake itself, and by a process which had built up the terraces and other structures of a similar kind, caused the geysers to send out heated water and the springs to deposit their minerals, the whole area to be covered with deposits of silicious sinter and other products, and charged the waters of the streams and lakes with silicious and other solutions, which were partially deposited in the depths of the lakes themselves in the form of mud, or carried away in finer proportions by streams running from the lake outlets of Rotomahana and Tarawera. In this way subterranean caverns of enormous proportion and extent must have been formed until the earth beneath the area alluded to, and indeed far beneath the bottom of the lake itself, must have become completely homeycombed by cavities, as the yielding rock was decomposed by the chemical agencies and carried to the surface by the never-ceasing action of the thermal springs. In this way, it is only reasonable to suppose that a point must have been reached when the rocks beneath could no longer sustain the weight of the thin crust of earth above, and then the final subsidence or collapse took place. When the great convulsion came, the water poured into the chasm from the lake and its surrounding streams.

Now let us picture to ourselves an immense body of water coming suddenly in contact with the deep subterranean caverns and chasms; this gigantic chemical laboratory, heated with steam, and sulphurous and other gases to a degree of which we can form no conception. What must have been the result? Why the instantaneous formation of a vast additional body of steam, which, by the intense heat below the surface, immediately attained to an extraordinary degree of expansive power. The tension of these vapours exercising a terrific pressure in every direction, with an irresistible force, widened the gap already made above, but only to increase their violence, as more water poured into the enlarged orifice. Convulsively propelled by the vapours thus liber-

ated, earth, mud, and steam, with columns of boiling water, were projected into the air. But there was still plenty of water to engender fresh explosive power, as the heated caverns were crashed in by the expanding vapour, as the water poured into their depths, and subterranean explosions shook the earth, and craters or vents were blasted out of the living rock. It was now that Mount Tarawera awakened from an age of slumber. Lake Rotomahana was blown bodily up, a column of steam shot 15,000 feet into the air, a gigantic fissure was formed, running in the direction of the great mountain; but the battle between steam and water still kept on beneath the surface, the pent-up vapours gaining fresh energy as the eruption spread, searched out the points of least resistance beneath the earth, and these were found in the direction of the volcanic channels which, during periods of former eruption, led to the craters of Tarawera, when the struggling vapours, inflammable gases, and electric forces, bursting from the depths below, with earthquake shocks, rushed through the great vents casting upwards with irresistible force huge stones and showers of ashes.

The Wairoa Mud.—The ejected matter emitted during the eruption in the shape of mud, and the widely distributed deposits of sand, formed a subject of much concern to the colonists, until its fertilising or non-fertilising effect upon the soil was more or less determined. The mud that fell on the fatal night and wrecked Wairoa, however, appears yet to be a kind of volcanic "fly in amber," as not a few seem to have their doubts as to how it got there.

Individually, I have never had any doubt whatever, and on this point I am again, with all due deference, at variance with the opinion expressed by Dr. Hector on the matter. He states, in his report to the Government, "that it has been suggested by some that this moist deposit was mud thrown out from the bottom of Rotomahana lake; but it is difficult to conceive," he proceeds to state, "how in that case it should have overleaped a strip of country four or five miles wide, where there is nothing but dry sand, before it reached Wairoa; and I think," he continues, "a more likely source for its origin is to be found in the sudden condensation of the front edge of the great vapour dust cloud, when it suddenly met the violent cold south-west gale."

Now, I submit as my opinion that this fall of mud did not arise from the sudden condensation of a hot dust cloud meeting with a current of cool air. It should be remembered that the wind during the whole of the eruption blew from the coldest quarters, veering from south-east to south and south-west. The mountains in the district were covered with snow, and the air from the outset must have been sufficiently cool to have carried on the same condensation throughout. Moreover, why, it may be asked, should this condensation by the south-west wind (which in reality could have been no cooler at that season of the year than that blowing from the south or south - east) have only acted for a brief period over an area of a few square miles, of which Wairoa was the centre, and where the mud was deposited in depths varying from a foot to six feet.

It should be remembered that, by Dr. Hector's own showing, the mud-cloud followed immediately upon the violent outburst, accompanied by a widely-felt earth shock and loud reports which reverberated through the atmosphere to enormous distances, and at the very moment when the enormous volume of steam burst forth from the site of Rotomahana, carrying pumice dust, and frequently rocks, to enormous altitudes, and causing the formation of a dense cloud in the higher atmosphere, marked by electrical discharges.

In my opinion, this dark black cloud was nothing more nor less than the deposit o silicious mud which must have been accumulating for ages in the depth of the lake, while the electrical discharges it gave forth were caused by the heated steam it carried up. When the great column of steam previously alluded to shot up to an altitude of 15,000 feet, the stiff silica-charged mud forming the sedmentary portion of the lake would be projected with enormous force to a terrific height, as if blown from a gigantic mortar, the strong south-west gale referred to by Dr. Hector blowing furiously at the time would act upon this enormous suspended body with tremendous power, and if a line be drawn from Rotomahana Lake to Wairoa, it will be seen that the body of mud was propelled onward in the direct course of the gale, until it fell by its own specific gravity, and doomed Wairoa to destruction.

The fact that the ejected mud "overleaped a strip of country of four or five miles wide between Lake Rotomahana and Wairoa," as Dr. Hector points out, should not be difficult to conceive, since, if the mud had not been acted upon by the wind, it would have fallen in or

around the immediate area of eruption; but being driven furiously onward by the force of the gale at a great height, any particles falling as it crossed the intervening space mentioned, being lighter than the original mass, would be propelled by the force of the air currents still further forward in the course of the wind.

In thus venturing to put in question two of Dr. Hector's theories concerning the eruption, I take this opportunity to state that he is an older man than myself, and as a scientist he has acquired a high reputation in the colony, and considerable recognition in England, and in thus openly challenging his opinion I gain consolation in the belief, from my knowledge of his public character, that he is one who will be quite willing that I should agree to differ with him upon a scientific question which it is not within the power of either of us to reduce to an actual fact.

Probability of Renewed Activity.

With regard to the probability of renewed activity nothing can, of course, be affirmed with any degree of certainty. I do not believe, however, that another eruption need be apprehended. I consider, from what personal knowledge I can bring to bear of the country, that the area of the thermal action, which formed the seat of the outbreak, is less likely to be affected by subterranean disturbance of a disastrous kind under its new condition than it was before the outbreak, by reason of the new vents or outlets for the volcanic forces, which must have hitherto been doing their work to a great degree pent up beneath the surface. The fact of the eruption lasting only in an intermittent way during about four hours, and that the eruptive focus only extended in a broken chain for about six miles along the old line of thermal activity, would tend, I think, to show that the disturbance was not deep seated; and I look upon it more in the light of a terrific explosion of superheated steam engendered in the way I have before endeavoured to describe. It is now likely that the centre of thermal action will remain comparatively quiescent with Mount Tarawera as the great safety-valve, although I am of opinion that it is quite probable if the hydrothermal action continue to increase in the recently disturbed locality, that the craters of Mount Tarawera will be gradually transformed into active solfataras, similar to those of Tongariro and White Island.

Damage done to the Country.

When the eruption first occurred its effects were greatly exaggerated, and it soon got abroad that half the island had been blown up. In reality the outbreak was confined to a very limited area, while its destructive effects were confined to a belt of country which, owing to its vast extent of pumice plains, was never fertile excepting where thick forests clothed the volcanic hills, and a luxuriant vegetation bordered its splendid lakes. It was over this sterile expanse that the volcanic dust was spread, and in those places where it has been distributed in a thin deposit, its fertilising properties have already been proved. The dust taken from places wide apart has likewise been tested by a careful system of experiments, by which it has been demonstrated that seeds planted in it spring up with as much vigour as if placed in the finest soils. Indeed, of the fertility of deposits of a like kind, I may cite an instance which came under my own observation.

During an exploration which I made of the New Hebrides, a magnificent archipelago of islands in the Western Pacific, I crossed the Island of Tauna, one of the most fertile of the group, and ascended its active volcano, which rose to an altitude of over 1,000 feet. Captain Cook describes this volcano, in his travels over 100 years ago, as belching forth flames and throwing out stones and ashes with clouds of volcanic sand intermittently all day and all night. When I ascended it, the same work was still going on in the same manner, and the natives stated that it had been doing so since time out of mind. When the wind blew from the west, the sand was carried great distances out to sea, but with the wind from the east, it fell in thick showers over the island, and during our journey we experienced one of these gritty falls. In a few moments, after a terrific report and explosion, when fire and smoke, and huge stones were sent forth from the mouth of the crater, the cloud of dust came sparkling through the bright sunlight, and the whole of the vegetation became covered with a coating of dust, the particles of which were so minute as to resemble the finest brown snuff. With the least breath of wind this dust fell from the trees to the ground, where it seemed to add an extraordinary fertility to the soil. The island was everywhere covered with a dense and varied vegetation, unequalled by any others of the group, and while on the other

islands the yam only attained to its normal size, on Tanna they are often three feet long, and weigh a quarter of a hundred weight.

Analysis of Volcanic Dust.

The dust, of various degrees of fineness, ejected from the volcano during the eruption was spread over wide distances in varying deposits. Mr. W. Skey, the colonial analyst, gives the result of two analyses of samples of fine-grained dust taken from Tauranga and Hicks Bay, which show a remarkable uniformity in their character, although collected from localities miles apart.

Analysis.

	Tauranga.	Hicks Bay.
Silica	60·74	59·37
Iron oxides	11·88	10·18
Alumina	16·09	17·96
Manganese	Traces	Traces
Lime	5·69	5·98
Magnesia	·96	1·19
Phosphoric acid	Traces	Traces
Water	2·26	2·21
Salts soluble in water	Traces	Traces
Organic matter	Traces	·99
Alkalis	2·68	2·12

The mud from Wairoa afforded 62·98 per cent. of silica.

Atmospherical Condition.

The springs of New Zealand are materially influenced by weather conditions, and Tongariro, the great active crater of the island, now in the condition of a very active solfatara, with its continual cloud of steam, may be looked upon as a leviathan barometer, and from its phases very reliable weather indications may be obtained. Although during the eruption most of the springs in different localities, as far as can be ascertained, betokened increased activity, it is remarkable that the barometrical readings at Lake Rotorua afforded no evidence of abnormal atmospherical disturbances. As self-registered on the instrument kept at the Government Sanatorium, the fluctuations were thus shown.

	Rotorua.	Reduced to sea-line.
June 8th, midnight	29·28	30·08
,, 9th, 6 a.m.	29·23	30·03
,, 9th, 10 a.m.	29·17	29·97
,, 9th, noon	29·12	29·90
,, 9th, 6 p.m.	29·00	29·80
,, 9th, midnight	29·03	30·01
June 10th, 2 a.m. (hour of eruption)	29·03	30·01
,, 10th, 4 a.m.	29·04	30·02
,, 10th, 6 a.m.	29·05	30·03
,, 10th, noon	29·05	30·03

New Wonders.

It must not be imagined that, by the changes wrought by the eruption, culminating in the destruction of the terraces, that the Lake Country has been robbed of all its wonders. It has still its charm of magnificent lakes, and is replete with thermal wonders of a unique kind. Here the visitor may still travel for a hundred miles through some of the grandest scenery in the world, buoyed up by a delightful climate, and charmed by the most enchanting landscapes; while he may bathe in mineral waters of varying temperature, which seem to impart strength to the body and vigour to the mind. Beyond this splendid region he may wander into a new Wonderland, where still greater marvels will soon be opened to the tourist and the pleasure seeker, and where the homestead will, ere long, take the place of the *whare*, and the solitude of the forest give place to the hum of the busy settlement. It is this delightful spot, just to the south of Lake Taupo, which, for its extent, cannot be rivalled in grandeur and variety of scenery by any place on earth. Here is a modern Switzerland under a semi-tropical sky, where tall mountains rear their heads to the regions of perpetual snow, and a splendid growth of giant vegetation spreads upwards to the ice bound peaks; here tall volcanic cones send forth their clouds of coiling steam, and park-like plains stretch to the shores of a lake possessing the dimensions of an inland sea.

DISCUSSION.

Sir George Bowen, G.C.M.G., said that having been Governor of that glorious colony of New Zealand—the Great Britain of the southern hemisphere—for several years, when his friend the Chairman was Speaker of the Colonial House of Commons, and knowing New Zealand so well, he was glad to take this opportunity of confirming everything which had been stated in the very interesting paper they had just heard. He had come down at considerable inconvenience to hear it, but in this case, as in many others, virtue had been its own reward. He had twice visited the lake country. On the first

occasion he took the Duke of Edinburgh, when he was his guest in New Zealand, and his Royal Highness always said it was the most interesting and agreeable trip he ever made in his life. They used to bathe in these lakes, and on these terraces, and in those days there were no hotels or churches, nor any white man's residence whatever. They went with a body guard of one hundred Maoris belonging to the tribe of Arawas, who inhabited the lake country, and had always been on the side of the Queen; and as they bathed by moonlight on these terraces, they used to stand round with large torches of pine, which cast a magnificent light. The meeting must not judge of the beauty of those terraces by the otherwise very accurate sketches of them which had been shown, because they must be fancied glittering like snow in the glorious sunshine, or, as Mr. Kerry-Nicholls said, like icicles. He could say a great deal about New Zealand and the system of Maori clans, but he would only say in a few words what was not generally known in England, that the Maori clans were something like the Highland clans in Scotland. There were some twenty-six of them, and, luckily, about one-half fought on our side, just as in 1745 one-half of the Highland clans fought on the side of the Hanoverian king, whereas the others fought on the side of the Stuart king. He recollected perfectly well a conference once with Sir Donald Maclean, a colleague in the ministry of Sir Francis Dillon Bell. The question was whether they should cross the Mangorewa creek and attack the king in his native dominions, and he recollected one of the chiefs pointing to a huge tree in the clearing of the forest, and saying, "Oh Governor, Tawahiao is like that gigantic tree left exposed in this clearing, if you attack it with fire and steel it will fall upon you, and smash you, but if you leave it alone it will wither and die of itself. My word to you is, Oh Governor, to leave Tawahiao alone;" and so they did, and now literally he would wither and die. Of course the English people now numbered ten to one of the Maoris, and there was no longer any danger from them. It was a most interesting and critical time that Sir Francis Dillon Bell and his colleagues in the ministry went through some fifteen years ago, when they had risings all over the country. He would only say further that he strongly advised anyone who had six months to spare to go and see New Zealand, for it combined in itself almost all the magnificent curiosities to be seen in Europe; you had geysers, hot lakes finer than in Iceland, glaciers and snowy peaks finer than in Switzerland, inasmuch as they rose like the Andes from the ocean. Again, there were fjords finer than those of Norway—great arms of the sea flowing among immense mountains, and glaciers coming down almost to the brink of the ocean, and nearly washed by the waves. In fact, as he had said, New Zealand combined in itself almost all the curiosities and all the extraordinary scenes of Europe. It was much easier to travel in New Zealand now than it was in Italy thirty years ago; there were railways to all the principal points, and magnificent steamers, which were quite floating palaces, to take you out there.

Mr. LANT CARPENTER said he desired to thank Mr. Kerry-Nicholls for the exceedingly graphic way in which he had brought many technical points before the audience, but there were two points particularly to which he should like to allude; one was the remarkably interesting calculation he gave with regard to the possible age of the terraces. That happened to be a point on which he had had a great deal of discussion with Dr. Hector, in the College Museum at Wellington, and he was good enough to give him a small portion of the terrace, illustrating what he then said to be the extreme rapidity of its formation. He gave him the wing of a bird which he had shot as it was flying over the terrace; it fell on to the terrace, and within a fortnight it was so completely encrusted with the silicious deposit that you could not recognise what it was. Mr. Kerry-Nicholls had mentioned one illustration in one part of the terrace, to show its extremely slow formation, and he mentioned this as an instance of the extreme rapidity of its formation in another part. The other point referred to in the paper related to the extraordinary rapidity of the formation of some of the fissures. He held in his hand a series of some forty photographs on paper, kindly sent to him by Dr. Hector, a print from each of the series taken by the search party. A number of these had already been shown on the screen. He saw in Dr. Hector's notes with respect to one of these photographs which had been shown, that this fissure, which was 500 feet deep, 600 yards across, and a mile and a half long, was blown out, as Mr. Kerry-Nicholls had said, from the side of the mountain in the space of three minutes. He was not in a position to give the data on which Dr. Hector arrived at that conclusion, but he gave it on his authority in his letter. He would again express his thanks to Mr. Kerry-Nicholls for the very vivid way in which he had brought this matter before the meeting.

Mr. LLOYD (Dunedin) also bore testimony to the accuracy of the account given in the paper of this wonderful scenery, having himself slept at Lake Taupo, and visited the terraces and glaciers.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Kerry-Nicholls for his interesting paper; and only regretted that some of the most valuable parts had to be omitted in reading for lack of time, especially those referring to scientific points, on which Mr. Kerry-Nicholls was peculiarly qualified to speak.

The resolution having been carried unanimously,

Mr. KERRY-NICHOLLS, in reply, said he was sorry he had not been able to read the paper in full, as he had taken some time in considering the various points indicated. It was a very difficult matter to lead an audience on step by step in the short space of time allotted him, to the conclusions he had arrived at. He hoped, however, that, by the aid of the views and diagrams, they had been able to gather a fair idea of the country as it was before the eruption, and afterwards. He hoped that no one would go away with the idea that New Zealand had lost its beauties in this part of the Lake Country, because the terraces had been destroyed, for there was still a great Wonderland to travel through, and those who had the opportunity of going through that region would still see before them a marvellous creation of natural monuments, unequalled for the extent of the area in which they were contained in any country in the world.

SEVENTH ORDINARY MEETING.

Wednesday, January 26th, 1887; JAMES GLAISHER, F.R.S., President of the Photographic Society of Great Britain, in the chair.

The following candidates were proposed for election as members of the Society:—

Binyon, Brightwen, 5, Henley-road, Ipswich.

Boake, Arthur, Southwood-lawn, Highgate, N.

Cormack, M. T., M.A., Shepherd's-lane, Brixton, S.W.

Dallmeyer, Thomas R., 19, Bloomsbury-street, W.C.

Sinauer, Sigismund, 9, Kensington-palace-gardens, W.

Stephenson, Joseph Gurdon Leycester, 6, Draper's-gardens, E.C.

Vernon, Rev. E. H. Harcourt, 104, Cromwell-road, S.W.

The following candidates were balloted for and duly elected members of the Society.

Baker, Walter Joseph, 160a, Southwark-bridge-road, S.E., and Wallington, Surrey.

Bradford, William, Carlton-chambers, 12, Regent-street, S.W.

Carter, James Harrison, 82, Mark-lane, E.C.

Etherington, John, 39a, King William street, E.C.

Forrester, Thomas, Crosse-hall, Chorley, Lancashire.

Mason, Thomas G., 32, King-street west, Toronto, Canada.

Wakefield, Charles Leonard, Lloyds, E.C.

Wigley, William Charles, 29, Stoke Newington-road, N.

The paper read was—

PHOTOGRAPHIC LENSES.

By J. TRAILL TAYLOR.

While there are few lenses which cannot, in some way or other, be made to conduce to the formation of a photographic image, yet does the photographic objective differ *per se* from all others in certain characteristics.

Arriving at a definition of what forms a photographic lens by contrasting it with the object-glass of a telescope, we find that, whereas the function of the latter is to produce an image of objects which are transmitted axially, or in near approximation to the axis, the former must not only do this, but more, for it has to take account of rays transmitted also at considerable obliquity to the axis, and, after such transmission, has to project these oblique rays to distances proportionately greater than axial ones ere they come to a focus, in order to supply the condition of a flat field. Hence the greater the obliquity of the pencils, the more elongated must be the converging beam, in order that this indispensable condition be fulfilled.

Again, whereas in visual lenses (by which term I here designate such as are employed in the formation of a merely visual image, as the telescope) it suffices to bring to a focus as many of the luminous or visual rays as possible, or as the irrationality of the spectrum and the glass at command will permit, the photographic lens has to take cognisance not only of these, but of those which, possessing inferior luminousness, have more energetic action. In the correction of a photographic objective for achromatism it is therefore desirable that the yellow and violet rays be united, in order that when a sharp image is seen at the focus on the camera screen, an equally sharp image will be produced on a sensitive plate placed on the same plane, technically known as working to focus, or having the visual and chemical foci coincident. To effect this in an astronomical telescope intended for photography, it is necessary that either the flint and crown elements of the

objective shall be separated to some considerable extent, by which the definition, both visually and photographically, becomes lowered, or to have a supplementary crown glass so adjusted as to secure this condition of coincidence.

It not unfrequently happens that in a photographic lens corrected perfectly to work to focus in the centre of the field, the photographic definition towards the margin will be found to be of a higher class than the visual image. From this we may deduce the fact that a formula by which direct or axial rays are achromatised, does not include the case of oblique rays otherwise than as an approximation.

At this stage it may be well to say that I am to speak of lenses which are formed of optical glass as we find it in commerce at the present time, and shall avoid the realms of conjecture as to the possibilities which may arise from the practical introduction of new kinds of glass which at present are still in the tentative or rudimentary stage. This topic belongs as yet to the optics of the future.

When photography was young, various devices to work with a large aperture, and at the same time to secure sharp definition, were had recourse to. It had been early found that single lenses would not answer, because of their actinic plane of representation being situated somewhat nearer to the lens than that of the visual focus; accordingly the single lens of the camera obscura was supplanted by the achromatic lens of the telescope, the surface of maximum convexity being placed to the outside. Owing to the circumscribed area of definition, the lens was afterwards reversed as regards position and a diaphragm placed in front. The value of Wollaston's meniscus lens was in time duly recognised as a means of securing an extended field; and a lens which I find engraved in a manual by Daguerre, published in 1839, is practically that which is being manufactured in the present year, 1887, subject in some cases to modifications, in others to none. At this juncture, and in the same year, Chevalier, a Paris optician, improved the illumination by combining two achromatic lenses.

But it was reserved for the genius of Professor Petzval, of Vienna, to make the grand discovery of the portrait lens. A year after Daguerre's discovery, the late Voigtländer, when calling upon Professor von Ettingshausen, was asked by that gentleman whether he could determine the refracting and dispersing power of different descriptions of crown and flint glass, because Professor Petzval, who was at that time filling the mathematical chair in the University of Vienna, had made the calculation of a photographic lens which could not be executed in consequence of the qualities of the glass to be employed not being then in existence. Voigtländer, intimating his ability to do this, was asked to call immediately on Petzval, and was given a letter of introduction to that gentleman, accompanied by the observation that by furnishing the means to execute this lens he would render great service to the world and secure for himself a high reputation. The result of the interview that ensued was that Voigtländer furnished the desired information respecting the qualities of the various glasses, which formed the foundation of the calculation of two combinations of lenses executed by Voigtländer, one of these being the well-known portrait combination in use at the present time, the other the orthoscopic lens, which was not introduced to public notice till 1857. The portrait lens was issued about 1841. Of all lenses extant, it is the one possessing the greatest angular aperture, by which term is understood the diameter of the lens in relation to its focus. In former times, when processes were less rapid than they now are, it is easy to conceive of the impetus given to portrait photography by the discovery of Petzval.

If a plano-convex lens, or one nearly of this form, be inserted in a camera and directed to the light, it will be observed that if the convex side be turned towards the view, an image more or less sharp will be formed at the focus, but that the area of sharpness will be exceedingly limited. By reversing the position of the lens, turning the flatter side out, the opposite result is obtained—there is no sharpness anywhere, but a generally better and more uniform image all over the focussing screen. This arises from spherical aberration, the margin of the lens when thus placed bringing the rays to a focus anterior to that effected by the central portions.

The condition for reducing this confused definition to sharpness is that a diaphragm shall be inserted in front of the lens under such circumstances that the centre of the picture shall be formed only by the centre of the lens, no rays finding admission to the margin of the lens but those which come from the side of the view to be delineated, and thus fall upon the surface in a more or less oblique manner. This diaphragm is therefore absolutely necessary with a lens of the nature

described, in order to secure flatness of field, with good marginal as well as central definition. It is, therefore, necessary that the diaphragm be situated a little distance in front of the lens, because it is only when thus placed that rays are allowed access to the lens, subject to the conditions mentioned, those which would mar the sharpness being thus excluded. It must not, however, be imagined that the same effect would be produced by reducing the diameter to the size of the aperture in the diaphragm, for in such a case, while the centre would be sharp as before, the sides would be badly defined.

What has been said of the plano-convex lens is also true of the meniscus. This latter lends itself, by its form, so well to the transmission of rays possessing a great degree of obliquity to the axis, that all lenses which are intended to embrace a wide angle of subject must be of this form; but the spherical aberration being greater in a deep meniscus, than in a flat lens, a stop somewhat smaller is requisite, in order to its reduction. The deep meniscus possesses properties of a well-marked difference from all others. Those who desire to see the finest exemplification of the so-called "depth of focus" possible to be obtained, have only to procure a meniscus of very deep form, expose its concave side to a bright object, such as a lamp flame, and observe the image. Having got it as sharp as possible, observe to what a great extent the lens may be moved backwards and forwards without the identity of the lamp flame ceasing to be noticed. It is true that it is surrounded by an aura of false light, caused by excessive spherical aberration, but the form of the flame itself is still there. In a deep meniscus the diaphragm must be small, and be placed comparatively close to the lens. This permits of the transmission of a very oblique ray, the incidence of the ray being more normal than in the case of a flatter lens; hence the reason why all wide-angle lenses, whether single or in combination, must partake of the external form of the deep meniscus and the diaphragm be placed near to the lens.

Aplanatism is a somewhat ideal term, and cannot with strict accuracy be applied to photographic lenses. It was originally employed in 1791 by a Scotch *savant*, Dr. Bird, to denote lenses free from spherical aberration, in like manner as achromatism signifies freedom from chromatic aberration. Popularly it is held to designate an objective which gives sharp central definition with its full aperture, no diaphragm being employed. But this even an imperfectly corrected lens will do, provided its diameter be sufficiently reduced. We can, therefore, only talk in this connection by degrees of aplanatism, which would be the better understood if we had a zero from which to start the scale. This zero might be made to equal $\frac{f}{1}$ or a diameter equalling the focus; but at any rate, the term as it at present exists has not a sufficiently definite meaning. With this by way of protest against the mythical expression, I observe that of all photographic lenses extant, the old portrait combination is that in which the property of aplanatism, or maximum angular aperture, is greatest. As is the relation of aperture to focus, so is the intensity of the illumination. While a large angular aperture conduces to rapidity, in the same degree is it adverse to penetration, or the property of presenting on a plane surface, and with a degree of definition which satisfies the requirements of the artist, objects situated at various distances. This property of penetration, or depth of defining—unthinkingly called "depth of focus"—is a power of great value to the photographer, and is induced by means hereinafter described.

The Optical and Focal Centre.—It is in many instances desirable that one should be able to know where the optical centre of a lens is situated. It is a property of this centre that any ray refracted by the lens which passes through it, emerges in a direction parallel to its incidence. It is from a point near to, although not quite at, the optical centre of a lens, or combination of lenses, that the focus must be measured. To find this centre draw two parallel radial lines, one from the centre of each curvature, and both being oblique to the axis: then connect the points at which they touch the curved surface by a line, which, in the case of a meniscus, must be prolonged till it meet the axis. The point at which this junction-line touches the axis is the optical centre. In class books on optics the following rule is given: "Multiply the thickness of the lens by the radius of one surface, and divide the product by the sum of the radii, and the quotient is the distance of the centre from the vertex of that surface."

In a *combination* of lenses there is no fixed point which can be termed the optical centre. The mistake is frequently made of assigning it to a position near the diaphragm which has not necessarily any relation to that of the centre, which can only have its position determined

upon knowing the precise circumstances under which the combination is to be used, for it has strict relation to the conjugate foci. What is commonly termed the optical centre in a combination is in reality the centre of conjugate foci, and this is determined by the conjugates, which may change with nearly every change of picture taken.

The *equivalent focus* of a lens is so termed from an image formed by it equalling in dimensions that made by a single lens. It has no relation to the misleading term "back-focus," so frequently employed. It is not difficult to conceive of an objective, the back-focus of which—that is, the distance between the posterior surface and the ground glass of the camera—may be four inches, while the real or equivalent focus is eight inches. As it is of great importance that photographers know precisely the foci of their lenses, I shall describe methods by which this may be ascertained. Let me first of all observe that, although it has been taught by some that the focus must be measured from the optical centre, this is not quite correct. In every lens or combination there are two nodal points, which are centres of admission and emission. They are sometimes designated the Gauss points, from the fact of Gauss having communicated an investigation of their properties to the Royal Society of Göttingen, in 1840. In the case of a simple bi-convex lens these points are situated between the optical centre and the surface, while in a meniscus lens it is outside of the lens, and a little within the optical centre. It is the back nodal point which concerns us at present, as that is the one from which the focus is measured. In a rectilinear combination this posterior focal centre is situated between the diaphragm and the back lens. Opticians interested in this are referred to Secretan's treatise on the true point from which the focus should be measured, or to Gauss's memoir.

It has often been recommended to determine the true focus of a lens of this nature by focussing the camera upon an object, so that the image and the object shall be of precisely the same size, and divide the distance apart of the two by four, the quotient expressing the true equivalent focus of the lens. This is altogether misleading as applied to the combination lens in common use, the focus thus obtained being greater than the true focus by nearly one-fourth of the distance at which the lenses are separated in the mount.

Out of several methods by which the equivalent focus may be ascertained, I shall mention only a few. Select a very thin spectacle glass which, after trial, is found to give an image on the focussing-screen of the same dimensions as that given by the photographic objective; and the distance of that glass from the focussing-screen, less one-fourth its thickness, is the focus. Or, having marked upon the ground-glass the precise spots upon which two well-defined objects depict their images near the margin on opposite sides of the screen, unscrew the lenses from the mount, and insert a pinhole diaphragm made in a thin metal plate. Rack the camera in or out until the images made by the pinhole correspond with that of the lens in dimensions. As before, the distance between the ground-glass and diaphragm is the focus.

The way which I prefer is Grubb's, on account of the ease with which it may be carried into operation and the accuracy of the result. On the ground-glass of the camera make two pencil marks at either end, each being a distance of an inch or so from the margin, although this is not material provided both are alike as regards distance. Having brought up a table to the window, spread upon it a sheet of paper, and upon this place the camera. Focus upon a distant scene, and rotate the camera until a well-marked object in the scene—such as a chimney or spire—is superposed on one of the lines drawn on the ground-glass. Now using the side of the camera as a ruler, draw a pencil line upon the sheet of paper upon which the camera is placed, and rotate the camera so as to superpose the same object upon the other mark on the ground-glass, and again draw a line upon the paper. Having removed the camera, for which there is no more use, continue by aid of a flat rule these two angular lines until they met at a point, then connect them by a line as in the capital letter A, which line must equal in length the distance between the two marks made on the ground-glass, and with a foot-rule measure the junction of the angular lines to the centre of the cross line, and you have the true focus of the lens.

Shroeder's method is also simple and excellent, although it implies the possession of a camera capable of extending to about twice the focus of the lens. Extend the camera until the dimensions of the image on the ground-glass and of the object in front are alike. Having marked the position of the camera back in relation to its baseboard, slide or rack it in until a distant object is in focus, and

again mark the position of the back. The distance between the two positions, or that through which the camera-back was made to travel from the first focussing to the second, gives the equivalent focus of the lens. In a rectilinear symmetrical doublet of wide-angular aperture which I possess, having an equivalent focus of $13\frac{1}{4}$ inches, a reputed focus of 13 inches, and a back tocus of $10\frac{3}{4}$ inches, I find that the focal point, or posterior nodal, is situated ·3 inch back of the mechanical centre of the lens. This is a matter that greatly concerns those who have to make copies to scale, and who have the sides of their cameras graduated in order to facilitate accuracy and speed.

I shall now show, projected on the screen, a considerable variety of photographic objectives, and make a few observations on each in turn. First of all I remark there are two ways by which a plano-convex, or a meniscus lens can be achromatised. A bi-convex crown may be wedded to a plano-concave flint, or a concavo-convex flint to a plano-convex crown. If the meniscus is to be very deep in its external form, its components may be plano-convex crown, cemented to a plano-concave flint, although opticians generally prefer that the contact surfaces be curved, on account of the greater command it gives them for the correction.

The earliest form of objective was the plano-convex, or slightly curved meniscus. For reasons already given, it has a diaphragm, or stop, in front. In order that it should work with a larger aperture, the late Grubb reversed the relative positions of flint and crown, by which he was enabled to bring the diaphragm rather closer to the lens. Still later, the late Dallmeyer modified it by placing the flint between two crowns, for which further advantages were claimed. By recent improvements in the selection of glass, and curvature, this old objective (which in all its various forms is still much employed) is now made with such a large fixed diaphragm, as to render it capable of being employed in portraiture. This of course is owing to the minimising of the spherical aberration. Whilst admirable in other respects it is unsuitable for copying or for architectural purposes on account of its refracting the lateral rays in a greater proportion than the central ones. This distortion does not show near the middle of a picture, but becomes apparent when the included angle is moderately wide. From the nature of its construction it cannot supply the condition of orthographic projection, viz., that a ray shall emerge in a direction parallel to that at which it enters. To this end the ray would have to pass through the optical centre, which in such a lens cannot be done.

The Petzval portrait lens consists of a nearly plano-convex achromatised lens in front, with a double convex posterior lens at the other end of the tube. This latter is composed of a bi-convex crown and a concavo-convex of flint glass, the inner curves not being concentric, and the two are separated to a slight extent. This back combination fulfils a two-fold function; it shortens the focus and thus intensifies the illumination, and as it possesses a large degree of negative spherical aberration, it counteracts the positive aberration of the front lens, and thus with a large aperture it brings rays to a sharp focus over a field quite large enough for single portraits. Some years ago, Dallmeyer introduced a modification of the back lens, reversing the relative position of its element, as Grubb had done with the landscape lens, the requisite negative aberrations being obtained, as in the Petzval back, by the inner surfaces not being concentric. This form of back lens lends itself to the lowering of definition, when such is desired, as in the case of large faces in which the rugosities of the skin are not always desirable.

An American optician, Morrison, makes some of his portrait lenses—especially those for taking a large standing figure with full aperture—with an uncemented front lens and a Petzval back, the inner surfaces of the front lens having non-concentric lenses.

The most recently introduced lens of the portrait class owes its inception to Steinheil, and is constructed on lines quite different from all others. The front is a cemented positive combination, and consists of a convex crown and a concave flint. The back combination is composed of a bi-concave flint and bi-convex crown, these being separated to some considerable extent. Each combination exhibits chromatic and spherical aberration to a large extent, but in an opposite sense, so that the two combinations correct each other.

He has also imported the same idea in the construction of a landscape lens possessing greater power, and in which the back crown element is of unusual thickness, and is cemented to the flint. It is claimed for this construction of objective that the marginal definition is of superior class, and that astigmatism has been eliminated. In the landscape form the lenses are set so closely together as barely

to permit a diaphragm to be inserted between them. The name "antiplanat" is applied to them.

One or other of the lenses above described is employed in everyday portraiture in the studio. It is that class by which the greatest angular aperture can be secured.

I have said that Petzval made the calculations of two objectives. The second, which lay in abeyance till 1857, was designated the orthoscopic lens, from a property claimed for it of giving rectilinear projection, but which subsequent investigation proved unfounded. Although it has been supplanted by others it is a useful lens, and gives good definition over a moderately large field with a large aperture. The front lens is the usual front achromatic of the portrait combination, with a smaller negative lens or dyalite placed a short distance behind. This dyalitic lens is composed of a meniscus flint and a bi-convex crown. This lens is useful when one desires to take a larger image than the extension of his camera permits, as its focal centre is anterior to the front combination.

Out of the orthoscopic lens were evolved others of different form which were free from the imperfection to which I have alluded, the most popular of these being the triple achromatic lens composed of three cemented compounds, the front and back being plano-convex or slightly meniscus in form, with an achromatic negative lens between them, by which the field was rendered flat.

The triple combination lends itself in an admirable manner to the production of what I may term a universal lens, by which I mean adaptability or adjustability of focus. Some years ago I constructed a lens of this class, in which a very wide slit was cut right through the mount in the position occupied by the concave lens. In this was fitted a sliding piece of brass pierced with four holes, in each of which was set an achromatised lens of a negative power. Notches on the slide ensured the lenses being quite central. The combination to which this system is attached is composed of two nearly plano-convex lenses, which when used alone do not give a flat field. By inserting the slide, the influence of either of the four concave lenses is to lengthen the focus and flatten the field. The foci I obtain by this slide are respectively seven, nine, twelve, and fifteen inches. When not in use, this slide packs away in a neat little pocket case, six inches long by one and a half inches wide, and half an inch deep. Of the advantage of being able to secure more or less subject on a plate, without having to unscrew or change the lenses, I need not speak.

Wide-angle, non-distorting objectives are a great power in the hands of a photographer who knows how to use them aright. Among the earliest of these was the American globe lens, so termed from the outer surfaces forming part of a globe or sphere. From the example now shown, it will be observed that each lens (the combination is symmetrical) is formed of a meniscus crown with the shorter radius from the optical centre, cemented to a concavo-convex flint. The construction of this lens favoured the formation of a flare spot, or ghost, in the centre of the picture, which would have disappeared had the maker departed from his globular idea, and brought the lenses a little closer together.

In 1864, Ross took the matter up and brought out a doublet free from the shortcomings of the globe. It was unsymmetrical in internal structure, being composed of a bi-convex and a bi-concave cemented front, and a concavo-convex and meniscus back combination. The lighter element, as you see, is to the outside of the front and the denser element to the outside of the back. Soon after this, Zentmayer introduced a ratio lens, one in which the front and back elements were of dissimilar diameter and focus, the diaphragm being placed in the optical not the mechanical centre. The objective was composed of two single or non-achromatised meniscus lenses of very deep curvature, and included a very wide angle. A feature by which it was distinguished consisted in a series of lenses of different foci all screwing into one mount under such circumstances as to retain the diaphragm in the correct position for all of them. This was improved upon by Dallmeyer, who made a wide-angle rectilinear lens in which the lenses are each achromatised.

A wide-angle lens much used in America, made by Morrison, consists of a very deep achromatic front lens and a single or non-achromatic crown meniscus as a back lens, of rather flatter form than the front. This, presumably owing to slight over-correction of the front, aided by the well-known adaptability of the deep meniscus form, defines sharply over an extended field. There are other forms of wide-angle lenses, but I have spoken of most of those of a representative character.

We now come to a class of lenses so similar to each other in construction that one diagram will suffice to illustrate all. They are those to

which the prefix "rapid" has been in many cases applied, in addition to a nomenclature so stupendous as would indicate the ransacking of almost every living and dead language to supply.

In 1866, Steinheil introduced a lens formed of two cemented combinations, adapted for covering a moderately large field with an aperture of a seventh of its focus. Instead of forming it of flint and crown glass, which would not admit of such an aperture being employed, he used two kinds of flint glass, one possessing a higher index of refraction and dispersion than the other. From their wide aperture they were designated *aplanats*.

Numerous makers took the matter up, some by servile imitation, others by making departures more or less slight. This objective, which is more or less good according to the skill of the optician by whom it is made, is, for all-round work, one of the greatest possible value, for in a fairly good light it acts as a portrait and group lens; it is sufficiently rapid to enable the photographer to secure horses, even railway trains, in motion; it is orthoscopic, or rectilinear, hence can be employed for copying, and provided care in this respect has been bestowed upon its construction, it serves as a landscape lens, in giving no ghost or flare. But it is unfortunate that some makers, in their efforts to render it otherwise perfect, do not realise the importance of providing against the defect named. The lenses are separated so far as to hit a happy medium between flatness of field and astigmatism, and this is not unfrequently attended with flare. I have invariably found that this defect may be cured by bringing the lenses a little closer together in the mount. Even so little as the width of two threads of the screw has proved to dissipate the flare spot, which in many cases consists of an image of the diaphragm, which has a relation of conjugate focus to the back lens when internal reflections form a factor in its production, although it is sometimes occasioned by reflections from the front lens. Some makers of this lens have departed from strict symmetry, and claim that a more satisfactory result is obtained by having the back lens a little shorter in focus than the front.

But to revert to Steinheil. He did not rest satisfied with the introduction of the lens just spoken of, but made another having less angular aperture and greater angular covering power. It is formed of material similar to the other, the lenses are very thick, and are set very close together. Owing to their small diameter, lenses constructed on this principle are singularly portable, considering their great covering power, and one of our leading optical firms in London has made a speciality of extremely portable lenses of construction akin to that projected on the screen, in which the mounts of all are of similar diameter, and fit into one flange.

Morrison, of America, makes lenses for which properties analogous to those described are claimed. He employs ordinary optical flint and crown glass, and corrects by making his crown lenses plano-convex, united to bi-concave flints, the contact surfaces of which are but very slightly curved. One peculiarity of this form is that definition fulfilling the requirements of artists is obtained by lenses having shallow curves, and being made of ordinary flint and crown, they are less liable to discoloration by light or abrasion by friction than if composed of dense flint. The lens shown on the screen also serves to illustrate the configuration of the American lencoscope objective, which being made of large dimensions and long focus, is mainly intended for large direct heads.

There are several other topics than those touched on which belong to photographic lenses. Among these are diffusion of focus, so called, or depth of definition as produced by spherical aberration, and by the use of a diaphragm; astigmatism; conjugate foci; lenses for special purposes, such as projection, enlarging, detective and panoramic cameras; the shape and use of the diaphragm and its proper position; the nature and cure of distortion; single or unachromatised lenses; the testing of lenses for the various aberrations, and lastly their grinding, mounting, and treatment. But it would be impossible to get all these overtaken in one paper.

DISCUSSION.

Mr. J. Mayall, jun., said he noticed, in the early part of the paper, a reference to the term aplanatism, but it appeared to him that the expression was perfectly well defined by the classical writers on optics. Coddington, the well-known inventor of the lens which bore his name, in a treatise on the "Reflexion and Refraction of Light" in 1829, defined it as meaning freedom from spherical aberration; and that definition was adopted by Sir John Herschel in his famous treatise on "Light" in the "Encyclopædia Metropolitana." He could not but think that if in the description of

photographic lenses it was used in any different sense—for instance, as Mr. Taylor employed it, as meaning the angular aperture of a lens—it was an extraordinary mis-application of the term. Of course he did not attribute the origination of that idea to Mr. Taylor, because it had been more or less used in popular treatises on photographic lenses, and even in Monkhoven's work on photographic optics. Mr. Taylor had referred to a great number of lenses of the old type, many of which were quite obsolete and of no use whatever. On the other hand he had touched on certain lenses recognised throughout Europe, as showing the highest point of excellence which had yet been reached. He took it that since the application of the dry-plate process the old Petzval form, in which an extraordinary aperture was given in relation to the focal length, was practically useless, and everyone now used lenses having much less aperture, but where the aplanatism was infinitely more perfect. Reference had been made to the lenses made by Steinheil, in which flint glass was used for the external lenses. That point was taken up by a distinguished mathematician in Paris, some ten years ago, M. Prazmowski, the partner of Hartnack, the eminent microscope optician, and it led him not only to utilising flint glass for the external lenses, but also to combining different kinds of flint glass, and he had a very distinct aim, viz., to get rid, in portrait lenses, of the separation in the back combination, which he obtained by using two different kinds of flint glass for each combination, and thus produced a lens with a very short focus, with each combination cemented, so that the reflection given by the surfaces being exposed to the air was got rid of. One of the first lenses thus made, was made for him, as the result of a long discussion with Prazmowski, and having brought it to London, he thought it would be interesting to Mr. Dallmeyer to see it. He remained about an an hour while he tested it, but he was surprised to find that, although he was known to have considerable technical knowledge, he had not the slightest conception of the nature of the combination, how the problem of getting rid of the separation of the back lenses was solved, or that the lenses were constructed wholly of different kinds of flint glass, no crown being used. He must confess that even that was now a thing of the past, because it dealt with lenses of the Petzval construction, with great aperture and short focal length, which might now practically be looked upon as out of date. With regard to new kinds of glass for use in lenses, Mr. Taylor seemed to think it was too soon to deal with that question, but he should like to say a word or two on the optics of the future, as they might be developed by new kinds of glass which had lately come into the market. It was perfectly well known in the microscopical world that, some time ago, one of the most distinguished mathematicians in Europe, who had paid special attention to practical optics, Professor Abbe, of Jena, and his friend, Dr. Schott, had worked out an immense number of experiments with the purpose of providing new kinds of glass which would combine a greater number of lines in the spectrum than had been hitherto combined. Of course that in itself was old, some of our most able mathematicians, such as Professor Stokes, Mr. Grubb, and the late Dr. Robinson, having applied themselves to the problem, any time during the last thirty years; but, unfortunately, their experiments had not ended in any practical result. In this case, however, Professor Abbe being the theorist, and Dr. Schott a practical man, there was a combination which led to a much more exhaustive series of experiments, and the result was that new kinds of glass were really discovered. The earlier experiments they made were not very remunerative; they took a deal of time, and did not lead to any commercial result; but the German Government generously came forward, and voted a large sum of money in order that the experiments might be continued. The practical result, so far, had been shown in two ways. First of all, telescopes of considerable aperture had been made by Bamberg, of Berlin, as high as eight inches of clear aperture; and as regards achromatism there could be no doubt he had reached a point which had never been attained before. That of course would be shown in practical results by the extremely convenient use of deep eye-pieces. It was was well known that when these were used with a telescope in which the chromatism was imperfect, a flare of clouded fringes was produced; but with the new glass the chromatic aberration appeared to be more highly corrected. Turning to a point more interesting to himself, this glass had been used for the improvement of microscopic lenses, and a new series had been manufactured by the well-known optician, Zeiss, of Jena, and there could be no doubt that he had attained more perfect corrections through a larger extent of aperture than in any of his objectives of previous construction; these objectives were therefore aplanatic in the sense in which the term was used by our classical writers on optics. As regards achromatism, the superiority over lenses manufactured with the older media was unmistakeable. Seeing these results, he could not help thinking that photographic lenses also might be much improved by the use of this Jena glass. He thought photographers had a right to expect from opticians that the necessary energy should be devoted to the problem of endeavouring to utilise these new kinds of glass, and to attaining results in photographic lenses comparable with those which had been obtained in the microscope. He was informed by Professor Abbe that Steinheil had had a good many samples of this glass, and that he had seen his way at any rate to improved forms, and before long he believed there would be an issue of new lenses by Steinheil, made of this material, in which a higher degree of achromatism would be attained with larger and flatter field. If English opticians did not follow in the same path, they would not deserve the support they had hitherto had in England and abroad, where their reputation stood

very high indeed. In France, Germany, and Italy, photographers, both amateur and professional, spoke of the quality of English lenses with great respect, and referred to them as being of a somewhat higher standard in the matter of workmanship than almost any produced on the Continent, not in the mere technical execution, but in evenness of quality, so that if a foreigner gave an order to an English firm, he would be almost certain to get a lens of a high standard of excellence. Many people here who had obtained lenses from abroad had not been so successful, and he might say that he had burned his fingers more than once. If you sent for a lens to Paris, you might get a good one, but the chances were you did not.

Mr. HENDERSON asked what lens Mr. Taylor would recommend, apart from portability, as best suited for an optical lantern.

Mr. SHEW asked whether the wide-angled lens shown on the screen by Morrison, containing a single back lense, gave straight lines—was it rectilinear.

Mr. DEBENHAM said he thought justice should be done to the memory of Petzval, and he was sorry to hear his lenses referred to by Mr. Mayall as things of the past, and to hear it said that they were infinitely behind newer combinations in aplanatism. According to Mr. Mayall's view, they were the only truly aplanatic lenses, because by his definition such a lens was one free from spherical aberration; and the peculiar characteristic of Petzval's lens which stamped it as the work of a great genius was the freedom of spherical aberration. This he obtained by separating the back lenses, and this had always been considered a great mathematical triumph. All portrait lenses, up to the present, had been constructed on that principle, with, in some cases, slight variations, such as reversing the back lens, but the great principle was the separation of the back lens into two parts, one of which had sufficient negative spherical aberration to overcome the entire positive aberration of the system, and so render it aplanatic. Several so-called aplanatic lenses had been introduced since; the first being the single lens of Grubb. Of course the term merely meant that the lenses were on the way to being aplanatic; perfection did not exist in anything; those that came pretty near to it were entitled to be so called; and for a single lens, Grubb's was a nearer approach than anything before. Then Steinheil—another man whose genius would always be admired whenever photographic lenses were spoken of—introduced a combination which he called aplanatic, because it was so nearly so as to allow of tolerable definition with a focal length of only seven times that of the aperture. The Petzval was four times the length, and sometimes less than that; and if any lenses existed more strictly aplanatic than Petzval's portrait lenses, he should be glad to hear of them. Petzval's served as a model for all lenses, and Steinheil's as the model for a host, for all the opticians imitated him. No doubt photographers would wonder why their pet lenses were not referred to in such a paper as the present, but the fact was, if those they were in the habit of using were merely copies or slight variations from these leading original types, it would not be proper, in a scientific lecture, to speak of them as originals. One of the most perfectly aplanatic lenses was Steinheil's portrait antiplanat; unfortunately, it lacked perfect flatness of field, more so even than Petzval's, and therefore, though it gave exceedingly fine definition over a small field, it required either a curved plate, or to be used only with a very small part of the field, to get perfect definition. Perhaps the most ideally perfect photograph which could be obtained would be one in which no provision was made for overcoming spherical aberration. If the plate itself were curved to receive the image; if the reproducing and enlarging processes were as perfect as they were sometimes said to be, the photograph could be taken in this way, but the plate would have to be in the shape of a bowl; it would be difficult to manage, to develop, and so on, and then it would have to be reproduced on a flat plate before it could be made use of for printing, and reproducing processes were not as yet so perfect that this method was at all likely to come into use. One lens Mr. Taylor had shown which he believed had gone out of use, which was much to be regretted, the wide angle doublet of Ross. Its place had been to a large extent taken by another combination of Steinheil's, the wide angle aplanatic; which certainly had the advantage of greater portability. In covering a large field on a flat plate the essentials were—first, the field must be flat; therefore, the marginal pencils must be much longer in focus than the central ones, and that condition was fairly fulfilled in the lens in question. Another defect in very wide angled views arose from the angle of illumination; the corners of the picture received much less light than the centre. The diaphragm opening, looked at from the marginal part of the picture, only represented an oval, having its longer diameter of the same size as the circle which was available for the central part of the field; in the next place, the corners were further removed from the diaphragm, and the image therefore was more separated, and thus again the corners received much less illumination than the centre. There was yet a third difficulty arising from the reflection at the surfaces of the lenses.

Mr. WERGE said he should be glad if Mr. Taylor could tell him how to determine the focus of a pinhole, as pictures of large and small size could be produced thereby.

Mr. TRAILL TAYLOR, in reply, said Mr. Werge

was very well aware that, according to the distance of the pin-hole from the screen on which the image was received, so would be the magnitude of the image. If it were six feet away it would be large, if only six inches it would be small. The object of the pin-hole was to produce an image of the same dimensions as that given by the lens in question, and that could be done by moving the pin-hole backwards and forwards until the two images coincided. That was all that was wanted. He made no mention of the focus of a pin-hole. Continuing his reply, he said the best lens for a short studio was a short focus lens, and you should get the camera as far away from the object as possible. With regard to lenses for optical lanterns, according to Mr. Mayall there were none, because it was a thing of the past; but he really thought he could not have been mixing so freely in the photographic world as he ought, or he would know that the Petzval was *the* lens *par excellence*—the only thing which could be employed for an optical lantern, either for projecting or enlarging, owing to its adaptability. Petzval's portrait lens was the one for the lantern; it was used in the lantern that evening and everywhere else, and he was a little surprised to hear Mr. Mayall say that it was a thing of the past. The most eminent opticians in the world were making them constantly. They might call them universal lens, or the A, B, C, or D lens, or any name they liked, but they were all Petzval lenses, and they were in constant use. The same gentleman had referred to a cemented back. Amongst the first lenses that emanated from the factory of Voigtlander were lenses with cemented backs; they were triple compound lenses of enormous aperture and very short focus, capable of working, as was facetiously said, in a coal-cellar. Voigtlander took out a patent for that again a few years ago, and portrait lenses with cemented backs were things of the present day. Mr. Mayall had also referred to lenses being made wholly of flint. When he described Steinheil's invention, he characterised it as being made of two kinds of flint glass, the denser element outside; and all the lenses of the present day characterised by the term "rapid," with the exception of the one he had spoken of as being American in inception, were made with two kinds of flint glass, the denser element outside.

The CHAIRMAN, in proposing a hearty vote o thanks to Mr. Taylor, said he hoped the new glass would cause so great an improvement in photographic lenses, that the next time they had a paper from Mr. Taylor, he would include it, and show the progress which had been made.

The vote of thanks was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 2.—"Sewage Irrigation." By ALFRED CARPENTER, M.D. Captain DOUGLAS GALTON, D.C.L., C.B., F.R.S., Chairman of Council, will preside.

FEBRUARY 9.—"Purity of Beer." By A. GORDON SALAMON. J. H. PULESTON, M.P., will preside.

FEBRUARY 16.—"Uses, Objects, and Methods of Technical Education in Elementary Schools." By HENRY H. CUNYNGHAME.

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

NOTE.—The paper of Mr. Reckenzaun, on "Electric Locomotion," announced for February 2nd, has been unavoidably postponed. It will be read later in the Session, and due notice of the reading will be announced.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

FEBRUARY 11.—"The Economical Condition of India." By DR. WATT, C.I.E. Sir GEORGE BIRDWOOD, M.D., LL.D., C.S.I., will preside.

MARCH 4.—"Our Trade Routes to the East." By MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B.

MARCH 25.—"Indian Coffee." By FREDERICK CLIFFORD.

APRIL 29.— "Village Communities in India." By J. F. HEWITT.

MAY 27.—"Indian Tea." By Dr. T. BERRY WHITE. H. A. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 15.—"Colonial Woods." By ALLAN RANSOME.

APRIL 19. — "South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 1.—Opening Address on "The Condition of Applied Art in England, and the Education of the Art Workman." By T. ARMSTRONG, Director of the Art Division, Science and Art Department. SIR GEORGE BIRDWOOD, M.D., LL.D., C.S.I, will preside.

FEBRUARY 22.—"Wrought Ironwork." By J. STARKIE GARDNER, F.G.S.

MARCH 15.—"The Application of Gems to the Art of the Goldsmith." By ALFRED PHILLIPS.

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

CANTOR LECTURES.

The Second Course will be on the "Diseases of Plants, with special reference to Agriculture and Forestry." By T. L. W. THUDICHUM, M.D. Three Lectures.

LECTURE II.—JANUARY 31.—Epiphytes or Fungi living upon, as distinguished from Endophytes or Fungi living within, the tissue of other plants.—Parallelism with Epizoa and Entozoa.—Description of the diseases caused by Fumago or foot-dew.—Mildews—their effects upon gardens, cultivated fields, and forests.—Fungi as medicines.

LECTURE III.—FEBRUARY 7.—Animal parasites as causes of epidemic plant diseases, illustrated by the Phylloxera. — Comparison with Oïdium.—Aphides or green-fly.—Survey of parasites on forest trees.—Necessity of greater attention to forest culture as a science.—Physical and chemical causes and effects of diseases of plants.—Comparison with vegetable ferments, beneficial and hurtful.—Diseases of wine and beer.—Conclusion.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. L. W. Thudichum, "The Diseases of Plants, with special regard to Agriculture and Forestry." (Lecture II.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. H. G. Lepper, "Swine Fever."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. J. Mackinder, "The Scope and Methods of Geography."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. Simpson, "Mud Architecture—Notes made in Persia and other Countries."

Actuaries, The Quadrangle, King's-college, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. Benham, "The Story of the Bastille."

TUESDAY, FEB. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. T. Armstrong, Opening Address on "The Condition of Applied Art in England, and the Education of the Art Workman."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture III.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Messrs. W. J. Dibdin and Mr. W. Sant Crimp's paper on "Sewage Disposal."

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. B. C. A. Windle, "The Anatomy of *Hydromys chrysogaster*." 2. Mr. Martin Jacoby, "Descriptions of the Phytophagous Coleoptera of Ceylon." 3. Mr. F. E. Beddard, "Notes on *Brachyurus calvus*."

WEDNESDAY, FEB. 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Alfred Carpenter, "Sewage Irrigation."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. Francis Galton, "Pedigree Moth-breeding as a means of verifying certain Constants in the General Theory of Heredity." 2. Mr. Frederick Merrifield, "Proposed Method of Breeding *Selenia illustraria*, for the purpose of obtaining data for Mr. Galton. 3. Rev. T. A. Marshall, "A Monograph of British *Braconidæ*." (Part II.)

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m. Annual Meeting.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. Lee Beardmore, "House Drainage."

THURSDAY, FEB. 3...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Aitchison, "Fauna and Flora of the Afghan Boundary."

Chemical, Burlington-house, W., 8 p.m. Ballot for the Election of Fellows.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. A. Barrett, "The Comic Songs of England." (Lecture II.)

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. Ashton Ellis "Richard Wagner, as Poet, Musician, and Mystic" (with illustrations).

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. W. Rücker, "Molecular Forces." (Lecture III.)

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Annual General Meeting. 1. Discussion on the late Mr. Robert Wyllie's paper, "Triple-Expansion Marine Engines." 2. Mr. Henry Teague, "Notes on the Pumping Engines at the Lincoln Water Works." 3. M. Marc Berrier-Fontaine, "Description of a Portable Hydraulic Drilling Machine." 4. Mr. Edgar P. Rathbone, "Copper Mining in the Lake Superior District."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

FRIDAY, FEB. 4...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. J. Goodman, "Recent Researches in Friction." (Part II.)

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Dr. Edwin Freshfield, "Some Unpublished Records of the City of London."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Mr. J. Boxwell, "The Place of Sanskrit in the Development of Aryan Speech in India."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Reading of papers, and discussion resumed.

SATURDAY, FEB. 5...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Ambruster, "Modern Composers of Classical Song—Johannes Brahms" (with Vocal Illustrations). (Lecture III.)

Journal of the Society of Arts.

No. 1,785. Vol. XXXV.

FRIDAY, FEBRUARY 4, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the first list of subscriptions promised by members of the Society of Arts to the Fund for the Imperial Institute :—

	£	s.	d.
Sir Frederick Abel, C.B., D.C.L., F.R.S., Vice-President	50	0	0
William Anderson, Member of Council	50	0	0
Sir William Andrew, C.I.E.	20	0	0
The Attorney-General, M.P., Member of Council	30	0	0
Henry McLauchlan Backler, F.R.G.S.	10	10	0
W. J. S. Barber-Starkey	5	0	0
Edward Beanes	5	0	0
Sir Francis Dillon Bell, K.C.M.G., C.B., Member of Council	30	0	0
George Blagden	2	0	0
John Bloomer	5	5	0
Francis Botting	0	10	6
Edward M. Browell	5	5	0
S. M. Burroughs (Messrs. Burroughs, Welcome & Co.)	5	0	0
Alfred Carpmael, Vice-President	20	0	0
Charles Cheston, M.A., Member of Council	20	0	0
B. Francis Cobb	10	0	0
Sir Daniel Cooper, Bart., K.C.M.G.	100	0	0
T. R. Crampton, Vice-President	30	0	0
Sir Juland Danvers, K.C.S.I., Member of Council	10	0	0
Professor James Dewar, M.A., F.R.S., Vice-President	10	0	0
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D. J. Russell Duncan	5	0	0
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Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of Council	50	0	0
George Godwin, F.R.S.	30	0	0
Professor D. E. Hughes, F.R.S.	5	0	0
	618	15	6
Brought forward	618	15	6
Henry Joachim	2	2	0
E. T. Kensington	3	3	0
Henry Kent	5	0	0
Edwin Lawrence, LL.B., B.A.	100	0	0
Jamse Leverson	2	2	0
Mrs. McGarel	5	0	0
George Matthey, F.R.S., Vice-President	30	0	0
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Sir Saul Samuel, K.C.M.G., C.B., Member of Council	30	0	0
Alfred Savill Tomkins	1	1	0
Rev. J. P. Tomlinson	5	0	0
Philip F. Walker	10	10	0
William Westgarth	100	0	0
J. H. Whadcoat, F.S.S., F.C.A.	2	2	0
R. R. Whitehead, M.A., J.P.	5	0	0
James T. Wood, M.A.	10	0	0
Total	1,102	18	6

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

MOTORS FOR ELECTRIC LIGHTING.

The Council have placed two additional Gold Medals at the disposal of the Committee, to be awarded as the Committee may decide, if the merits of the motors entered in competition should in the opinion of the Committee render such additional awards desirable.

There will, therefore, now be Four Gold and Four Silver Medals open for competition.

The conditions of the competition were published in last week's *Journal*.

Forms of entry can be obtained on application to the Secretary.

CANTOR LECTURES.

Dr. THUDICHUM delivered the second lecture of his course on "The Diseases of Plants, with special reference to Agriculture and Forestry," on Monday evening, 31st January The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

SECTION OF APPLIED ART.

Tuesday, February 1st, 1887; Sir GEORGE BIRDWOOD, M.D., LL.D., C.S.I., in the chair.

The CHAIRMAN said:—The duties of the Chairman at our meetings here are, as a rule, restricted to introducing the reader of the evening's paper, and keeping the discussion which usually follows it within the limits of its particular range and intention, and these ceremonious functions should be generally discharged by the chairman in as strictly formal a manner as possible. But on the present oecasion, which is that of the first public meeting held under the direction of the Section on Applied Art, recently established by the Council of the Society of Arts, it is perhaps advisable that I should begin our proceedings by offering you some observations on the purposes, as they appear to me, to be fulfilled by the new Section, the commencing session of which Mr. Armstrong has, at the special request of the Council, most kindly consented to open with his paper on "The Recent Condition of Applied Art in England, and the Education of the Art Workman." The Society is making no new departure in organising the new section. It was founded more than a hundred years ago for the promotion of Arts, Manufactures, and Commerce, and the papers printed in its *Journal* form an almost continuous history of the remarkable progress of the applied arts in this country since the Great Exhibition of 1851. Under the isolating influences of protective duties, levied to defray the costs of the great wars against Bonaparte, they had gradually sunk to the degraded condition in which they are found from about 1836-46. In the latter year the corn laws were finally abolished, and from that date the new life, in which we are all, down to the humblest in the social scale, now rejoicing, began to revivify the languishing artistic genius of our race. The beneficent change first became noticeable in the formative arts of architecture, sculpture, and painting. The mere Custom-house and other recorded figures in regard to the last are most striking in this connection. Between 1836 and 1846, the continental supply of pictures, attributed to the "old masters," went on increasing with the English demand until, in 1846, the importation of them reached the number of 14,000. From that year it rapidly dropped, and in a few more years became altogether extinguished. On the other hand, while in 1834, "The Storm," by Etty, could not find a purchaser at £70, and the annual sales of English pictures at the Royal Academy, in 1840, did not amount in money value to £1,000, Etty's "Storm" would now fetch quite £1,000, and the Royal Academy annual sales amount, or amounted a few years ago, to over £20,000. The improvement was slower in manifesting itself in the applied arts; and necessarily, for they are the handmaids of architecture; although it often happens that, as Cicero says, "He who should be the master sometimes takes the place of the slave, and the slave that of the master."

"Fit in dominatu servitus, in servitute dominatus."

It is true that the "Mechanics' Institutes," which were resuscitated in 1857 under the Science and Art Department, had been founded by Birkbeck in London and Glasgow so early as 1823, and gradually, through the advocacy of men like Haydon, were established in all parts of the United Kingdom; and, later, followed the Government "Schools of Design," the first of which was opened at Somerset House in 1837. But nothing effectual was done until the Great Exhibition of 1851, which marked the real turning point in the history of English decorative art in the 19th century. It was indeed a terrible parade of our shortcomings, as unreserved as it was voluntary; but its salutary lesson was at once grasped by us, and in the aggressive spirit imbued in our blood and bone, we began that strenuous competition with the Continental manufacturers which has at last placed us, in the mechanical production of works of applied art, at the head of all the countries of the West. The transformation was completed even by 1855, when the French began to recognise that we were no longer their humble tributaries, and were soon likely to become their most powerful rivals in every one of the special developments of the applied arts, of which they had so long enjoyed a virtual monopoly. The great agents in this renewal of the artistic life of the country have been, first and foremost, the old British pluck and public spirit of our manufacturers; next, the Science and Art Department, which arose out of the head School of Design, established at Marlborough-house in 1852, and transferred to South Kensington in 1857; and lastly, such private organisations as the Scottish Art Union, the London Art Union, and the Society of Arts. The Exhibition of 1851, in fact, had its origin in the initial discussions on it raised within these walls by the late Sir Henry Cole. The Society has further contributed towards the regeneration of the national applied arts by the publication, in its *Journal*, of a series of lectures recording almost every year the successive practical advances made in these arts during the last fifty years. As examples of these papers, I would cite the Cantor Lectures delivered here by Mr. W. Burges in 1864, and by Mr. Alan Cole in1881; Mr. Sparkes's paper on pottery in 1874 and 1875; and the Cantor Lectures delivered last year by Mr. Lewis Day. The Society has also, from time to time, offered prizes to art workmen. It is, therefore, only in the natural course of circumstances that this Society, which began

in 1851 to take a leading part in fostering the development of the applied arts, should now, in view of the yearly-growing importance of their cultivation to the prosperity of the country, form a special section on them; just as some years ago, in view of our expanding Colonial and Indian interests, special Colonial and Indian Sections were formed. If we have progressed in every direction during the last fifty years, so have our Continental neighbours around us; and it will be quite impossible for us to maintain our proportional supremacy in the keen commercial competition with the nations of the West, and the naval and political ascendancy based on it, unless we can also maintain our staple export manufactures at the highest pitch of artistic as well as of mechanical excellence. As to our "plan of campaign," it will be the same as it has always been; not "seeking for some great thing to do," but leaving ourselves to be guided wheresoever we may be led by each day's obvious duty. We shall invite papers dealing with the ever-varying circumstances, and the actual productions at different times of the applied arts in this country, and it will be our invariable endeavour to obtain them from the practical experts best qualified, in the opinion of their contemporaries, to treat of the subjects their papers may embrace. Our procedure will therefore be entirely empirical; but in this way we shall gradually collect a body of practical information of the greatest interest and value, affording a vast inductiou of facts, such as no single experience could accumulate, on which to found those generalisations that should govern alike the art producer who would advance with the times in the application of art to production, and the despised art theorist. We shall also, I hope, reinstate prizes for art workmen. And if in their different ways, our manufactures, the State, and private societies such as this, are true to themselves, we may be perfectly sure that there is reserved for our national applied arts, whatever stress of competition they may have to contend with, as remarkable a development in the immediate future as in the immediate past. England has uniformly headed the nations of the Continent in all the higher branches of European culture. In poetry, in philosophy, in the science of government, in industrial and commercial and social economy, we have kindled every light under which they are still slowly toiling their way out of religious, and political, and economic darkness; and it will be strange indeed if we fail in maintaining the lead we gained in 1855 in the van of the art manufacturers of the West. One word of explanation before I bring these introductory remarks to a close. I have associated our artistic development in the past fifty years with the triumph of free trade principles in this country. It is, indeed, quite impossible to avoid doing so. But I must not, therefore, be supposed to be a free trade doctrinaire. Where it would destroy an indigenous art, destroying with it the whole economy of a still sacro-sanct, because still antique society, of which it is in every phase of itself but the outward token and indeed the sacramental symbol, as for example, in India, I would resist it to the end. Where it would prevent the development of a truly national, that is, self-contained art, "racy of the soil," as in new countries like the United States of America and our Colonies, I would resist it until a national art was established in them, of which there are already signs in Australia; or until protection began at last to act injuriously on their art. But for us in the immediate past, free trade has been the salvation of our national art, and it will be so to the end for us, and for all the nations of the West, whose civilisation, unlike that of the sacro-sanct peoples of the East, is not based on co-operation, but competition. It has also served to inspire our highest spiritual life. It has quickened our sympathy with other nations in a way impossible for the co-operative religious communities of the East—which we erroneously regard as nations—ever to fully appreciate, and it has inspired us with a sense of kinship with the whole world which cannot fail of the widest-reaching humanising results, far off though their fulfilment may be. Therefore, in citing here to-day the names of those who have co-operated in the artistic regeneration of England, we may justly include among them that of Richard Cobden, to whom may be applied with a greater fulness of meaning than their author dreamed of, the noble words with which Seneca sums up the character of Alexander the Great:—"He mixed the elements of the nations together, as in a loving cup, and they drank of them, and forgat their old weaknesses and animosities, and were one." It now remains for me to call upon Mr. Armstrong to read his paper.

The paper read was—

THE CONDITION OF APPLIED ART IN ENGLAND, AND THE EDUCATION OF THE ART WORKMAN.

By T. Armstrong.

Director of the Art Division, Science and Art Department.

When the Society of Arts did me the honour to ask me to read a paper at the first public meeting of this new Section, it appeared desirable that I should look about and make myself acquainted with what had been written and said on the subject of late years, to find if possible the limitation and definition of what we are calling Applied Art, or Art applied to Industry. Nomenclature as to art or the arts has been very vague; we have heard of the "ingenuous arts," and the "fine arts," and in the last century the "polite arts" were much talked of. The form "Art Applied to Industry" is in common use in France

and Italy, and with the same meaning as here—"L'Arte applicata all' Industria," "L'Art appliqué à l'Industrie," and in Germany it has an equivalent in "Kunstgewerbe."

We have, I take it, to deal with ornamental or decorative art, and I find that in the announcement of Mr. W. Burges's Cantor lectures of 1864, to which I shall frequently have occasion to refer, they are described as "Lectures on the Fine Arts Applied to Industry."

Usage has gradually of late years been limiting the application of the term art to the fine arts, and in common parlance the term "art" is generally confined to painting, engraving, etching, drawing, and sculpture.

A recent authority, accepting for the word Art, or *ars*, the etymology which refers it to a root *ar*, of which the primitive signification will have been to put or fit two things together, quotes John Stuart Mill's definition—"Art is the employment of the powers of nature for an end," and says of "those arts which fashion useful objects in one way rather than another, because the one way gives pleasure, and the other does not, as architecture and the subordinate decorative arts of furniture, pottery, and the rest; that it is of their essence that they cannot be practised by habit, rote, or calculation; habit, rote, or calculation may help the artist in a certain way, but in the essential parts of his art he passes beyond the reach of rules and acts by what is called inspiration, that is, by the spontaneous and unreasoned workings together of infinitely complex and highly developed sensibilities and dexterities in his constitution."

If I have detained you to read what you will find, with its context, under the word "Art," in Black's "Encyclopædia Britannica," above the initials of my friend Mr. Sidney Colvin, it is because I feel strongly the necessity for some better and more definite nomenclature for the processes with which we are called upon to deal, and for those who practice them, for if we could label the art workman, the fine art workman, whose skill is exercised for adding an element of fancy or pleasure to an element of utility, in such a way that the world generally would esteem his calling more highly, we should certainly create an inducement for young men, with natural gifts and cultivated skill, to practice these crafts, or, being in them, not to leave them for the painting of easel pictures, or the modelling of portrait busts, which, besides being more profitable occupations, carry with them the title of artist which the English have of late taken delight in honouring. If the converse of the old proverb, "Give a dog a bad name and you hang him," be true, then we might hope by designating the real art workman by some descriptive title which would convey the idea of his being an artist, one whose art cannot be practised by habit, rote, or calculation, but in its essential parts is beyond the reach of rules, and is the product of which is called inspiration resulting in pleasurableness, we should do much to help him to the position I thinks he longs for.

Littré tells us that the French word, "artiste," only took the meaning it now has since 1762; relatively it was formerly "artist in tapestry," "artist in metal work;" absolutely, artist, he who was a chemist, who worked at the great art—*le grand art*.

This ancient Society has, from time to time, sought to further the cause of fine art workmanship by causing lectures to be delivered in this room, and I find that three and twenty years ago a sort of general survey of the fine arts applied to industry was made under its auspices, in the form of Cantor lectures, by an architect the most ingenious of his time, who was held in great esteem for his erudition, and notable as taking a great interest in all the decorative arts—Mr. William Burges, whose untimely death we have had to lament.

It thus appears that there is no new departure to-night except in form, and that the functions of this new Section of the Society, though now for the first time specialised and set apart for the supervision of a sort of sub-committee, have been exercised in a greater or less degree for many years. The lectures delivered by Mr. Burges were, however, more comprehensive, and on that account more important than the others, for in them he dealt with the history of the applied arts in the past, their state at the time he spoke, and expressed his hopes and expectations for their future. This was twenty-three years ago—nearly a quarter of a century—and now again the Society proposes to make further efforts in the cause we all have at heart, and to provide a course of lectures, delivered by specialists or experts on the subjects treated by Mr. Burges, or similar ones, and I have reason to hope that they will be what may be called clinical lectures, delivered in the presence of specimens of the subject matter, and will tend rather to the narration of experience than the promulgation of dogma.

I think I cannot do better than take these

lectures one by one, quoting briefly Mr. Burges's opinions as to the actual state of the art with which he was dealing in 1864, and his hopes for its future, and then point out the measure in which his expectations have been realised or the contrary, especially in that direction which is most familiar to me. In the first or introductory lecture, he mentioned and rejoiced at the action then being taken by the Government towards the furtherance of art education among the people, by the establishment of schools and the creation of the South Kensington Museum. He looked upon the great English exhibitions of industry, initiated by the Society of Arts, as powerful agencies for good, and thought that the then recent Exhibition of 1862 had shown that we were getting on. He regretted that the artisan was hardly taking so much advantage of the art schools as he might have done. Of the hindrances to future progress he gave as the principal ones these—

(1.) A want of distinctive architecture which is fatal to art generally.

(2.) The want of a good costume which is fatal to colour.

(3.) The want of sufficient teaching of the figure which is fatal to art in detail.

And finally, after a review which may be termed very hopeful, he concluded with these injunctions:—

(*a.*) Increase the Government schools of design.

(*b.*) Multiply local museums, and render them easy of access.

(*c.*) Educate the designer as thoroughly as possible, but above all, teach him the figure; and, if you can, catch the artisan and teach him as well.

And he gave up style and costume which, being beyond our control, must be left to time and Providence.

Now, with regard to the realisation of the hopes and fears of Mr. Burges, expressed twenty-three years ago, it may be said that the establishment of schools of design, or schools of art, as they are now called, has gone on increasing, and that they now number 198, whereas in 1864 they were only 91; while the number of students under instruction in the schools of 1864 was 16,555, it was 36,960 in those which were at work last year. The Government grants in aid have increased since 1866 from £4,112 to £25,301, under the system of payment by results.

There are besides, 488 art classes at work throughout the country, the art class being a less costly and more humble instrument for instruction than the school of art, the latter being bound to have premises wholly and solely devoted to art training, whereas the art class can use rooms which, when the class is not at work, may be let for other purposes.

In these classes drawing from the cast is practised, though from the nature of their tenure large figures are seldom used there, but ornament is generally drawn, and sometimes modelled, from the round, and the mason, or fitter, or builder can get in them instruction in geometry, in building construction and machine drawing, which will certainly make him a better workman, and prepare him for the more advanced teaching of the School of Art.

In 1864, Mr. Burges told us, the artisan had not taken so much advantage of the schools of design as he might have done. We have to lament the same backwardness now. It is true that in many—I may say most—towns in the United Kingdom there are hardly any trades depending on the arts of design; but there are no towns in which the building trade is not represented, and those belonging to it, including house painters, might certainly be convinced that the teaching to be had in art schools and art classes would make them better workmen, and would open the way to promotion. Until there is some such conviction, the mass of working men will not be persuaded to attend school in the evening, after a day spent in hard manual labour, for mere love of knowledge or skill in the abstract. They must be shown that the probable gains of the self-denial required for this, will rapidly lead to higher wages and greater consideration.

The system of instruction aided by the State in schools of art and art classes, had its origin in Mr. Ewart's Committee of 1835; and here it may be well to remind you—for we live in times so hurried that our benefactors quickly drop out of memory—that the country owes much to the painter, Haydon, for his powerful help in the movement which led to the arousing of public opinion, and the appointment of this Committee. He was eloquent and persistent, deeply convinced of the necessity or desirability of doing something to educate the people to the perception of beauty, by practice in drawing, and by putting before them good examples; and in London and in the large provincial towns he pleaded earnestly and effectually, by speaking at public meetings, and by private letters to public men who had the power to help the cause.

The system, as at first established under the Board of Trade, has undergone many changes. It has been often and virulently attacked, and even at the present day, I do not find that the work of the Department is hailed with satisfaction on all sides. I am not here to-night to appear as its apologist; but, in passing, I would call attention to what I consider the misapprehension of its aims among a large body which ought to be sufficiently interested in the subject to take pains in getting at the facts—I mean artists and architects.

The work of all the schools and classes receiving aid from the State is sent up annually to South Kensington for examination; and on the results of this examination the grants are made, and prizes and medals are awarded to the students; grants only being made on the work of what is called the artisan class, or of students whose parents declare their income from all sources under £200 a year. The limitation is perhaps a rude one, but in this way a line is drawn more easily than in any other. All, or nearly all, those who work for weekly wages are thus included, and it is for the benefit of such that the State has intervened. To give you some idea of the magnitude and complication of this undertaking, I may mention that the number of drawings and models sent up for inspection last spring was over 800,000, showing an increase on the previous year of about 38,000 or 39,000.

It will occur to some of you that much of this work might be done on the spot with advantage, but experience has shown that the present plan is the only one by which something like evenness of standard, and what may be called fair play, can be attained; but if the mass of work goes on increasing, it may become too unwieldly to be dealt with in London, and then some process of fair selection—difficult to manage, but, I hope, not impossible—may be resorted to, and payment may be made on some other basis of calculation, where the samples sent up show that the instruction given is sound in character. There are many reasons for hoping that some such change may be effected without impairing that fair distribution of State aid which is our constant aim. Among these is the want of sufficient space in our still unfinished buildings which, during the examination season, compels us to have a great number of our staff working in overcrowded rooms and passages for long hours, where gas-light must needs be used all day long.

After a process of sifting, which goes on during two or three months, the advanced works are passed on to the national competition examiners, who are the best experts the Department can find. Those of the last few years include Mr. Poynter, Mr. Marks, Mr. Leslie, and Mr. Yeames, for the drawing and painting of the figure and for still life; Mr. Boehm, Mr. Armstead, and Mr. Hamo Thorneycroft for the modelled work; Mr. William Morris and Mr. Walter Crane for designs; Mr. Aitchison and Mr. Stephenson for architecture; Mr. Alan Cole for lace designs; and Professor Unwin for machine drawing and building construction. By them the medals—gold, silver, and bronze—and the book prizes are awarded, and then the premiated works are exhibited to the public at South Kensington, and are generally sent also during the autumn to three or four of the most important schools for a short period. This exhibition presents to the public the best work of the country during the year, and the awards made represent the direction which the examiners think it best to give from head-quarters. Herein lies the great value of prizes to the Department, and their justification, for they serve to point out to the country the kind of work which the Government, acting on the advice of persons of recognised skill and knowledge, thinks it right to encourage.

It is much to be regretted that this very important exhibition, representing as it does to the taxpayer the outcome of his money voted for art education, has often of late years been most unworthily housed. Last year it was held in that survival of the once notorious but not unpopular Brompton Boilers, which served until lately as the Patent Museum. The lighting was bad and the building was shabby, and the general impression outside was that the exhibition is thought of little moment by the Department, and that any hole or corner is good enough for it. Twice within the last five years has it found a decent home, both times in unfinished or still unappropriated parts of the museum; in the new art library before the books were removed into it, and again in the court now used for the educational library, and the corridor adjoining where the textiles are. On other occasions it has been stowed away in what are called the southern galleries, on the west side of Exhibition-road, in rooms certainly better lighted than the remains of the Boilers which served last year, but which are at least

quite as shabby, and what is more important, so remote that nothing, I am sure, short of a band of music and a refreshment bar would attract people to them who have no keen personal interest in the competitions.

We all regret this very much—but what are we to do? In ordinary times, when the needs of the spring examinations are not pressing on our shoulders, we waste much of our energies by trying to put a quart into a pint pot, and do what we will, we cannot show the fine things we have in the museum to advantage. Until new buildings are erected at South Kensington, I see no chance of our showing these collected works of the whole country in a proper manner. As money is not available, and if it were voted now many years must elapse before the buildings would be ready, I should be glad if suitable rooms could be hired in some very central situation where, for six weeks or two months in the summer, all those who care about the work the Department is doing could come and see it without inconvenience, and see it in a good light and with decent surroundings.

At any rate we are anxious that the results of the teaching, helped by public money, should be seen as far as possible by those who pay for it, and especially by those who control public expenditure.

The schools, with the exception of those at South Kensington and at Edinburgh and Dublin, are not Government schools, though they are commonly so called. They are under the control of local committees, who appoint masters and retain or dismiss them at their pleasure. The masters, it is true, must have at least one certificate of what is called the first group, but the certificate of one such master at the head covers the teaching of others who may have none.

This cannot be too often repeated to those who criticise our work, or too steadfastly borne in mind by them if they wish to judge it fairly.

When the need for art teaching is felt in any locality, and those interested in it constitute themselves into a committee for action, the Department meets them by saying, "If you will provide suitable premises, well lighted, properly warmed and ventilated, and will undertake that they shall be devoted exclusively to art teaching, and that the school shall be open in the evening to artisans paying fees, we will help you (1st) to build or alter premises by a grant, in proportion to area, up to £500; (2dly) by paying half the cost of suitable examples and fittings; (3dly) by payments on all works executed to our satisfaction by students of the artisan class, and for examinations successfully passed by them."

Payments are only made on work of which the Department approves as tending to the promotion and elevation of art applied to industry, but much other work is done in schools obtaining grants, for in many places these schools would never have been established, or would have ceased to exist, if the wheels of the machine had not been kept greased by the fees of the upper and middle classes, the Government grant and the small fees of the artisan class not being sufficient to pay the expenses.

The amateurs who come in numbers to the schools to learn a little painting or drawing are but seldom induced to go through such a serious course of study as becomes a State-aided, or what is called a Government, school of art; but the masters have been led to look to the fees of such as an important part of their income, and if a young lady is not at once allowed to paint and to copy chromo-lithographs, she is apt to take offence and leave the school. It is true that there are some exceptional masters who are strong enough, either by coercion or persuasion, to get their pupils to more serious study, but generally I think they have to give way. I cannot say they are to be blamed for this, for there is no breach of contract, and it has always been a principle with the Department to induce the middle and upper class to take advantage of schools of art which, even in the larger towns, cannot be much used in the daytime by the artisan class, so that the consumer as well as the producer of art manufactures may be educated.

Although many of these have never gone through the hard grind which in art, as in every other pursuit, is the only means of acquiring real skill or knowledge, there can be no doubt that, directly or indirectly, much good has been affected by their attendance at the schools, for it must be borne in mind that, in most towns in England, the people, high and low, have been starved in the matter of art.

Art museums in the provinces are of recent growth, and there was little or nothing, except in the finer churches, which could have any effect in raising the taste of the people. In olden times, before the Reformation, the treasury of a cathedral was a sort of museum, in which beautiful stuffs and metal work were stored, but of classical art there was nothing,

and of Renaissance art objects for secular use no more.

Every school of art has always had some casts of good ornament and of antique statues, or portions of them, and many schools were provided with copies of most of the famous statues of antiquity and with some portions of the Parthenon frieze. Besides, they have had electrotypes of good metal work, and each school has had a small case of original art objects on loan from the South Kensington Museum. All these things were such as they would not find elsewhere in their native towns, and familiarity with them must unconsciously, at any rate, have done much to give them impressions of beauty in art, and to prepare the way for the effect of finer and larger collections to be seen in after life away from home.

In one respect, at least, familiarity with these casts from antique sculpture has had an important result, for the representation of the human figure is not now in any class the source of trivial joking and prurient remarks, as it was nearly everywhere some thirty years ago; and the objections to the study of it, which seemed futile, but to the teacher were serious enough, have been slowly but steadily removed.

This, then, is so much to the good; but, on the other hand, the amateur tone thus given to the schools has been a serious disadvantage, and I believe that the artisan class is in many places impressed with the idea that they are not meant for such as them to get instruction which will really help them in their struggle for existence, but rather for the recreation of those in a class above them, and I look upon this as a misfortune. No pains should be spared to do away with this idea, and to induce the masters to lay greater store on artisan students, and devote the best of their energies to them.

You must bear in mind that this drawback, which I lament, was inevitable if schools of art were to be generally established throughout the country, and that no grants being made on the work of amateurs, no expense is incurred for them by the State, except for prizes. Some interesting statistics have been got out within the last few days, bearing on the progress of art teaching throughout the country during the last six years, which show that whereas in 1880 the proportion of artisan students was 50 per cent., it is now about 70 per cent.

I now come to another very important branch of art instruction—that to which we look for the greatest all round improvement—I mean the teaching of drawing in elementary schools, which, as most of you know, has latterly been put on a new footing. The position two years ago was briefly this:—Drawing paid for by the Science and Art Department had been making progress, until the standard was raised about six years ago, partly in consequence of the rapid increase in expenditure. This raising of the standard deterred many from taking it any longer, and for the most part, those who did continue to take it cared so little about the subject, that it was thrust aside on every excuse for other subjects on which the Government grant was more easily obtained, for the Board school teachers, whose duties are multifarious, found it easier to master bookwork than acquire and keep up the skill in blackboard drawing which is necessary for teaching the large classes in an elementary school. There were exceptions, few and far between, and I have met masters who, being properly qualified and taking an interest in the subject under the old system, since the standard was raised, produced results which procured for them grants satisfactory and remunerative.

To remedy this state of things, drawing has lately been made a Class Subject under the code of the Education Department. Under these new conditions, it will be taught thoroughly if at all; but in many schools the managers find that their maximum grant can be gained more easily by taking other Class Subjects to the exclusion of drawing.

It is, after all, a question of expenditure, and if Parliament can be convinced that drawing is really important, and that the Governments of France, Germany, and Belgium have not vastly overrated it, a sufficient grant will be given to insure its being taught in every elementary school for at least one hour and a-half a week. This allowance of time is not to my mind sufficient, though I have seen very good progress made in some schools with no more, for I am in the minority of those who think that the education in the Board schools, though not too much in quantity, is in character far too literary.

You must not suppose that drawing in elementary schools is confined to what is technically called freehand, and drawing from models and common objects which tend to what we call art or fine art, and cultivate the faculty of observing the appearances of things. It includes drawing to scale and geometry, both valuable exercises for mental training, and

leading to achievement in what must be useful in the practical business of life to everybody, gentle or simple.

If once such a system of teaching drawing in all our elementary schools can be established as will lead to every boy leaving them after having fulfilled the condition of, even say, the 4th Standard, as set forth in the syllabus attached to the Code, the teaching of drawing in art classes and schools of art will at once assume a different character. The raw material with which they are now fed will give place to young people with that skill of eye and hand which is best acquired in boyhood, and with a fair knowledge of perspective and geometry, and the depressing grind of such study will not have to be gone through in the evening school after the hard work of the day. The work will be much more stimulative both to master and student, and, with proper teaching and good examples, neither of which we need lack, very important changes for the better will quickly follow.

By a system of scholarships or free studentships, of which the germ now exists, the boys with aptitude for drawing could be passed on to the art classes and schools of art, and elementary and secondary education would be continuous.

The instruction given in the best of our schools is, I believe, excellent for the pictorial artist in his youth; though our endeavour is to overcome the tendency and desire, among those but imperfectly acquainted with the exigencies of our position, to force us into a course which can only develop prematurely, and without sufficient training to ensure real excellence, a supply of purely pictorial artists.

Of these, I am told on all hands, there are more than the demand requires, and though we all hope for better times, the most sanguine among us can hardly look for the "flush" which brought prosperity to painters of pictures between 1860 and 1880.

The purchasing power has not kept pace with the producing power, and we are in danger of getting into the state illustrated by Salvator Rosa in one of his satires, where he tells us that Pope Paul V., on receiving a deputation which asked for the free export of corn from the States of the Church, replied that he could not let the grain go, but he would gladly give them permission to take out a cargo of painters.

It is not, however, our business to train painters of pictures, as such; the Royal Academy does that, and the other academies of Fine Art throughout the kingdom.

I remember being much amused at hearing from a friend of mine an account of what sometimes happens when a sailor is engaging himself on a ship. He is required to state his religion for registration, and it seems he generally asks in reply, "What are you short of?" He is told, perhaps, "We have Churchmen and Roman Catholics, Independents and Wesleyans, but there don't appear to be any Baptists." "Very well," says Jack, "Put me down a Baptist." Nobody can say we are "short of" painters of easel pictures just now, and I think it might be well for some of our young people of talent to get "put down" for some line which is not overcrowded, and, if they are really A.B.'s in their profession, they can sail under another denomination next voyage if it should be found worth while.

Having now led you through a wilderness of details about the work of the Science and Art Department, for which my excuse must be the conviction that I was asked to read this paper entirely on account of my official position, I will proceed with my review of Mr. Burges's opinions and hopes.

Next in importance, in Mr. Burges's estimate. to the establishment of schools of art, was the exhibition of the already fine collection at the South Kensington Museum. This has gone on increasing in importance till it is the subject of envy of all foreign governments, which are now so earnestly striving, by careful search and great expenditure, to place good examples of art workmanship before their people, and its utility is no longer confined to London and the schools of art. There are now thirty museums, established under the Public Libraries Act, and affiliated to the Department, which are regularly fed from the central collection. These loans are changed periodically, and in them are included many objects of great pecuniary as well as artistic value. Special exhibitions too—promoted for purposes connected with the establishment or enlargement of schools of art—are held from time to time, with help lavishly bestowed from the same source.

During the last year, a return was made of the number of objects out on loan at one time, and it was found that at least 30,000 original objects, besides reproductions, were in circulation.

In this respect there has certainly been great progress—where it was much needed—

and there is reason to believe that these loans are greatly appreciated by the general public in the localities to which they are made, but we have no assurance that the class for whose special edification they are designed—the the class of art workmen—profits to the utmost by the opportunities for serious instruction they afford. Their usefulness would, I believe, be greatly increased by courses of lectures delivered before the objects, such lectures as those planned for the present season by this Section of the Society of Arts.

State aid has, noreover, been given since 1881, to local museums, in the shape of a contribution of 50 per cent. to the cost of examples for their permanent collections. This help is, for the most part, held out for the acquisition of reproductions, obtained by means of photography, casting in plaster, and the electrotype process, of famous works of art which cannot readily be purchased, and if purchased must be very costly. These reproductions, when good of their kind and faithfully executed, are, as all here know, for the purposes of study, identical with the originals, and their educational value cannot be overrated. Aid from this vote is not confined entirely to reproduction, and in many instances original objects have been acquired with the same allowance. Notably, I would mention a collection of textiles bought by one of the Manchester museums, which contains some specimens of early printed cottons superior to any of their kind at South Kensington. Purchases made under these conditions have of course to be submitted for approval to the Department, and by this means a direction can be given towards the acquisition of examples really valuable—on which artistic opinion is well-established—rather than of objects remarkable only for their rarity or for their novelty. There are signs that these local museums will rapidly increase, and probably the central authorities will be called npon to help them with a less sparing hand.

In 1864, so far as I remember, we were all very sanguine as to the great effect for good of industrial exhibitions which then, as now, had so large a place in the public mind. Mr. Burges thought he saw in them a very powerful instrument for the furthering of good art. Perhaps we expected too much, at any rate I think those who looked for good rather than cheap work have been disappointed. Opened with Royal pageants, and with the solemnity of prayer, they remained for months a source of innocent recreation to thousands of people, in whom urbanity of manner has been promoted by mixing in great numbers. We were all thankful for the amusement we found in them, and were—after human fashion—glad when they were over.

We are not yet in a position to judge fairly and accurately of the good and harm these exhibitions may have done to art, but they certainly set people thinking, and the Science and Art Department owes its origin to the first of them. Their effect on trade is matter rather suited to the consideration of a Chamber of Commerce than of a Society of Arts.

Dress has not been modified for men in the direction desired by Mr. Burges; but in the materials for women's clothes, it must be allowed that becoming colours can now be obtained in great variety, such as an artist would have gone a day's journey to obtain five-and-twenty years ago, and stuffs which are soft and pliant, and lend themselves to graceful folds, are to be seen in every shop window.

Men's everyday dress remains what it was, and many of us are well pleased with its comfort and convenience, though we do not enliven the streets and landscape with it. I do not see how any change is likely to be brought about in our time, unless a Bill should be passed insisting that, as rank has duties as well as privileges, peers of Parliament should not appear out of doors, between dawn and dusk, within the four-mile radius, without their state robes. If this were done, the colour of the western and south-western districts would be much more brilliant. But, after all, what is sauce for the goose is sauce for the gander, and I must say it would make my life a burden to me to have to travel daily between Campden-hill and South Kensington in an official uniform.

From the artist's point of view, there is one very great improvement of late. Numbers of young men, well built strapping fellows, are to be seen about, riding bicycles, and on their way to play foot-ball, in tight-fitting jerseys and knee breeches, which give opportunities for studying the human figure in motion quite unknown when I was young. And this brings me to Mr. Burges's injunction to encourage drawing of the human figure as much as possible. I believe this is done, and I invite those among you who care enough about the matter to visit the National Competition Exhibitions, and note for yourselves how it is done. You will find that the highly-stippled drawings from the antique, which were com-

monly done fifteen or twenty years ago at the cost of many months' labour, have gradually disappeared, having been discouraged for at least twelve years. Careful work is looked for and encouraged, but painful elaboration of surface is never rewarded for its own sake. In one or two exceptional cases which I remember, medals have been given to drawings which appeared to have been too long in hand, but on these occasions the distinction has been conferred not on account of this but rather in spite of it, and in recognition of really good qualities of drawing and modelling; and this has been pointed out, at least in the most notable instance, in the examiner's report, which is printed and published every summer, and which I commend to your notice.

There are, however, other and perhaps more important exercises in figure drawing worked by our students which do not come before the public, though I think they might be shown with advantage; I mean the time studies done during the third grade examinations in the spring. These have increased in number and improved in quality during the last three years; and in another branch or stage of instruction, that of designing figure compositions to fill given spaces in a decorative manner, the improvement last year was sudden and most gratifying. The report of Mr. Crane, the examiner of these works, is published. These time studies are done under strict conditions of examination, in which the student can have no help from books, masters, or fellow students.

The modelling done from the figure in some of our schools, especially in the Training School, and at Lambeth, is better than any work of the kind I have seen in schools of similar aims abroad. Hanley produces excellent modellers' work, and Manchester and Birmingham are making good progress.

It is, and has been, a common reproach to us among foreigners, that our decorative artists and art workmen are lamentably weak in figure work, and I hope this reproach is in the way of being removed; but in one respect the students — in our central school — are at a great disadvantage compared with those in foreign schools, whose works are held up for the purpose of putting us to shame, for we are debarred by public opinion —the public opinion of a few—it must be said, from studying from the female nude model. To the decorative artist, this is indeed a most serious drawback, for in that branch of art the female figure is much more useful and much more used than that of the male.

It may be remarked in passing, that the most distinguished of the foreign artists employed in the potteries, of whom we have heard so much lately, Mons. Solon, produces works in which the nude or slightly-draped female figure nearly always appears.

Mr. Burges's second lecture was on glass. It was for the most part historical, but coming to our own time, he applauded the work of some of his contemporaries, and declared that if we allow somewhat for age and size, a window by Mr. Jones or Mr. Holliday, executed wholly in streaky glass was as good as any old one that ever was made, and if we could get an unlimited supply of them, that he would certainly not lament the loss of "all the old ones, at least those in England and France."

After briefly treating of mosaic and enamel, he concluded thus, "I think it will be agreed that there is a pretty wide field open to the manufacturer even in glass and its various applications, and as we have got stained-glass as good as the old, let us hope that some day we may have drinking glasses rivalling the Roman, and enamels which surpass those of Limoges, both of the early and the later school."

The improvement in stained-glass windows has certainly gone on, and those who did the good ones then are doing better now, and the atrocious ones of Mr. Burges's day are now much less bad. In the kind of design taken up by some of our best artists in this material, it seems to me they have succeeded admirably, and their works are more beautiful than any produced before them; but there are other kinds in which our contemporaries have not yet succeeded so well, and I should be sorry to let go the old windows, for it seems to me we are not yet in a position to replace them in all their varieties. It is gratifying to know that this art has gone on improving, and it is edifying to seek the cause of the improvement. Putting aside the fact that some of the most highly endowed men of our time have devoted much of their energies to this art, I think we may ascribe its wholesome development in some measure to its being for the most part controlled by those who ought to control all the minor arts—the architects. The architects of our time—especially some of the most successful of them—have many sins to answer for, and owe to us much in the way of compensation; but they are, at any rate, educated in art, and are not in general swayed by commercial motives. Moreover, there is, when a glass

window is ordered, the kind of contact between producer and consumer which one would like to see in all transactions about art work. The designer or maker knows where his work is going; he is often obliged to consider the views, and even to humour the whims, of his employer, and to that end is brought into personal relations with him, and he sees his work through to the end.

With regard to mosaic and enamel there is much to be said, and there is no reason why both these arts should not be extensively cultivated in England. There are artists here who design admirably for mosaic, and the material, by the richness of its effects, and its power of resisting the grime of an English town atmosphere, is one which may be used with advantage. It seems to me that there are many developments of this art, hardly known in England, which are worth attention.

Enamel applied to metal in a coarse way for domestic utensils is common in England, and cheap, and I do not see why the finer side of the art should not be developed, especially in the jeweller's and goldsmith's work, where its use, in a translucent form, gives effects of the greatest beauty. I noticed, when in Paris last autumn, that this material is now extensively used by the French jewellers.

Through the kindness of Professor Roberts-Austen, who is greatly interested in the process, we were enabled last year to have the use of the metallurgical laboratory in the Science Schools at South Kensington, for a class consisting of twelve of the best of our students, under the instruction of M. Dalpeyrat, a skilful artist in enamel, who has executed copies of famous works for the Department, Each student drew and painted a piece of ornament, first in opaque white on a dark ground, and afterwards heightened the effect of it with the translucent glaze over gold and silver, in every stage firing it himself. The result was very satisfactory, and I hope that more may be done in this direction by others, for such technical work is outside our real function. If this Society were to give one of its substantial prizes for a piece of good enamelled work, the money would be well spent.

The third lecture by Mr. Burges was on pottery, a subject on which much has been said and written. He applauded what was being done, and had only to suggest better forms for the cheaper articles.

It would appear that there is little or nothing more for us to learn in England about the materials and processes used in making and decorating pottery. It only remains for us to use them with greater judgment and discretion. The recent discovery of the great frieze of enamelled pottery or majolica which adorned the palace of Darius the Mede among the ruins of Susa—the Shushan of the book of Esther—must suggest to those who see it when it is ready for exhibition in the Louvre, the possibility of adorning the exterior of our buildings with a material which lends itself to modelling and to the greatest beauty of colour, and has a surface which can easily be kept clean, and which need not be so smooth and so highly glazed as to reflect unpleasantly.

The Director-General of the Louvre has promised to provide us with casts of a portion of the frieze of Archers, which will be coloured as far as possible like the original; and we are to have also bits of the original glazed bricks representing all the colours used.

I hope this Society will see to it that experiments are made in the glazing of bricks of a similar kind, and perhaps it may be possible to have something done in this direction for the constructional section of the Science collections at South Kensington.

In the lecture on brass and iron work, after a short historical review, Mr. Burges asked, why more small bronzes were not made in England? We may put the same question today, and with more reason, since the beautiful and interesting method of casting by the "cire perdue" process is no longer an unknown art among us. Here, at the Royal Academy, and at South Kensington, lectures and demonstrations have been given on this, and castings in the method are now being made by at least one artist in London. In the career of the young modeller or sculptor one of the greatest obstacles is the costliness of the material in which he has to work, and the necessity for producing for exhibition works of large size which are difficult to house, and are beyond the means of all purchasers except the very wealthy. If small original works in bronze could only be brought into vogue—works in which every touch of the artist is faithfully rendered in metal of beautiful aspect, and perhaps heightened in effect with gold and enamel, the sculptor's art might be practised with more certainty of a market, and the houses of persons of moderate means might be adorned with examples of the best modelled cast the country could produce.

Latterly, some of our best artists have taken to producing medals after the style of the

noble examples of the Italian Renaissance, and perhaps this may lead to some improvement in our coinage, which leaves much to be desired. If the Society could induce attempts at better work in this direction, we should all be grateful, for art of that kind goes into everybody's pocket.

In brass *repoussé* work there has been a considerable advance during the last twenty-three years, and I think the processes connected with it are well enough known, and it can take care of itself. So with wrought iron, in which there is distinct improvement during the last ten years; and indeed there is, it seems to me, no craft of the kind in which the artistic outlook is more hopeful, for now we have plenty of very good work produced in this branch, whereas a skilful smith was rare enough about 1870.

Cast iron has not, so far as I know, made any such advance. Mr. Burges suggested decoration in bridges and various other structures of that material, then, and still more now, so common. The proper or artistic treatment of iron in building is a large question which remains to be solved.

The wail with which Mr. Burges began his lectures on gold and silver may just as reasonably be uttered by us to-day. Speaking of the testimonials which we English are in the habit of lavishing, he said:—"Whatever form it may take, the design, and frequently the execution, but too often leave a very great deal to be desired, and to anyone acquainted with what was done in the Middle Ages and Renaissance, there is really no sight more saddening than the interior of a silversmith's window." Then, as now, any person of taste who wanted a piece of silver plate, went to the second-hand shops for it.

This is, of course, not altogether the fault of the dealer, who must supply such things as he can find a ready sale for. Many of the largest and most important examples of this art which are made for presentation have to be executed with a haste which is wholly incompatible with preciousness of workmanship. In the ordinary productions in gold and silver, or silver gilt, much of the beauty of the material is sacrificed by the mechanical evenness of surface, and the excess of polish by which, in precious metal as well as in marble, colour is lost in reflection.

There are a few signs that the precious metals may be put to nobler uses again. Some of you may have seen the most interesting and beautiful Fawcett memorial which was uncovered last Friday in Westminster Abbey. This work, by one of the very best artists seen in England in our time, is a new departure; and I have heard within the last few days of an important piece of goldsmiths' work being offered directly to the hands best fitted to execute it.

This Society might certainly do good by offering prizes to artists who would produce pieces of plate suitable in size and character for various boating or football prizes, or for presentation to mayors, magistrates, or clergymen. The demand for such things, in fairly good times, is very large, and if a few good examples could be made and exhibited, perhaps the taste in such matters might be raised, and the dealer or middleman might find it quite as much to his interest to sell good things as bad ones.

In the beginning of his lectures on "Furniture," Mr. Burges complained of the "enormities, inconveniences, and extravagancies" of our modern upholsterers. Here he is fruitful in suggestion, and although much has been done in the way of improvement since 1864, enterprising cabinet-makers and upholsterers might still act on his suggestions with advantage. This Society, too, might, perhaps, obtain from experts information, to be generally diffused, on one kind of furniture which is now seldom made, I mean the smooth and highly varnished or lacquered woodwork. Paint carefully rubbed down to a very fine surface, like that of a coach panel, or metal—silver I believe is the best—tinted with coloured lacquer, yellow, reddish, or greenish, have, besides the richness of colour which cannot be too much sought after in our dark houses, lighted with a feeble and rare sunlight, the advantage of being easily kept clean, even in London.

In wall papers and hangings for houses, patterns of good designs in form and colour are much more easily obtainable than they were twenty-three years ago, and, on the whole, there is good progress here.

Mr. Burges asked why our houses were not more often painted with ornament and figures. Here there is certainly room for improvement, and if the young house-painters could have training in schools—a training which is, I fear, not so often now to be had in the workshop as formerly—in the designing and painting of ornament, decoration of this kind might be made more common, because less expensive. The skill of the Italian workman, working for low wages, is most remarkable, though his taste in colours is far from satisfactory. Most of us who have travelled in Italy proper, or on

the Riviera of Genoa, have been astonished at finding even the inferior bedrooms in hotels, decorated with hand painting skilfully executed.

Apart from the want of skill in our workmen —skill which might be brought out if a demand should arise for it, and I am sure that kind of work could be taught in schools—there is a serious hindrance in the tenure of houses in London. People do not like to spend money on houses which are not and can never become their own property, where, for instance, if a good chimney piece is put up by the tenant to replace the commonplace, ill-proportioned, and often unsightly one, placed there by the builder, he is bound by law to leave it when his lease or agreement expires, and cannot simply put the old one or a similar one, back, and leave things as he found them, unless he can get special permission from his landlord.

Really good decoration in houses cannot be looked for generally until the occupiers of them have that greater interest in their beauty which can only exist with fixity of tenure. Perhaps the promised measures for converting leasehold into freehold may be passed, and then we may look for a change.

With regard to "The Weaver's Art," the subject of Mr. Burges's last lecture, there is not time to say much. Here, again, much progress has been made, and stuffs for hangings, beautiful in colour, and of good design — copied or adapted, in many instances, from fine old examples such as we have in abundance at the South Kensington Museum — are not uncommon. For some of the more costly kinds there is, of course, but little demand; but I believe that these could be made, for the necessary processes are well understood. The wealth of material is greater than ever. The practice of hanging silk on the walls of rooms in some of the more palatial houses is, I think, gaining ground again, and it has occurred to me that the best way of enriching the appearance of our finest cathedrals and churches, stript of the coloured decorations which were customary at the time they were built, would be by loose silk hangings, to be put up on feast days if too precious for everyday use. This I should prefer to the alternative of painting them or veneering them with more precious material, for they are much too valuable to play tricks with and make experiments on at present, when the kind of art required cannot be procured, or only within narrow limits and at great cost.

One part of our subject, painted decoration, is too vast to be dealt with now, but I would call your attention to some of the more recent works—such as Sir Frederick Leighton's pictures in spirit fresco at South Kensington, the second having been finished a few months ago, and Mr. Madox Brown's series of paintings in the Manchester Town-hall. These latter can only be seen by making a long journey, but next summer there will be an attraction in the shape of a great Fine Art Exhibition in that city, and I trust those who go to it will not fail to visit Mr. Brown's most interesting paintings.

It would be useful to have some account of the way in which this great work has been carried out, and I have thought that perhaps Mr. Madox Brown might be induced to relate his experiences in London, either here or in the lecture theatre at South Kensington.

For the consideration of the art workman's condition and prospects to-day in England, I have left myself but little time.

I would make him an artist as far as possible, in his own estimation and in that of the public, and would add to the practice of the workshop, which is indispensable, the culture to be obtained in the museum and in the school.

The alternative to making the artisan into an artist is to induce the artist, as we call him, to take a turn in the workshop, and learn the craft of the artisan, to do neither more nor less than what is done by young men qualifying as mechanical engineers or millwrights. Many of them, the sons of wealthy parents, who have paid very high premiums for them, after giving them the best education in theory they can obtain at school or college, don fustian clothes, and work at the bench like the poorest apprentice. In this way they acquire, if not mastery, at any rate that knowledge of processes which is necessary for directing the work of others.

The training of the skilled art-workman must begin very early in life, and if in the near future we can count on a boy coming out of a Board School with trained eyes and hands to draw with, and perhaps to model, we shall be in the way of letting him profit rapidly by what he sees in museums, and what he studies in the advanced classes of the Art School.

Above all things, make him an artist; teach him to feel a pride in his work, and let him know that it is appreciated, and that he will get as much credit, or nearly as much credit,

from executing a fine piece of metal work or wood-carving as he would from having a picture on the wall of an exhibition. Do not let him be suppressed by the dealer who sells his productions, but let his name be attached to any piece of work in which there is originality of grace or skill, or new combinations of pleasurable invention.

I have had some experience during the last few years of young art-workmen who are brought to the Training School at South Kensington, there to receive free instruction with the help of a maintenance allowance. There are always fifteen such, and they are bound to have practised some trade depending on decorative art before coming into the school. Many of them are strongly moved to give up their trades on leaving us after a period of two years, and to take to the painting of pictures or the modelling of busts, and I can quite understand it and sympathise with them. I have, however, a firm conviction that much could be done to keep them in the trades to which they belonged if they could receive the consideration in their respective callings which is given to the painter of a picture which is exhibited. Perhaps this can best be arrived at by exhibitions of works contributed by the people who made them, and not by those who sell them. The laudable effort about to be made by this Society, not for the first time, of giving prizes to art workmen for good pieces of work, points to the establishment of such exhibition; for, to begin with, it must be desirable to let the public see what has been sent in competition for these prizes. A few choice works executed in each department of decorative art would, I believe, in a short time, influence the lower strata, and the cheaper works would improve in quality, and so the trade of the country would be affected. We cannot rapidly influence the taste of the public, nor force conviction on the purveyors of art-manufactures—the middlemen who rule the ordinary producer without strong views of his own—that perhaps the consumer might possibly care for better things than he can get now, and would pay more money for a little more preciousness in the work. The smaller industries, from which alone really artistic work can be looked for, should be encouraged. The hurry of the times in which we live tells on our attempts to foster good art-workmanship, and the lengthened apprenticeship, or period of pupilage, which was formerly submitted to, is not, so far as I know, to be found anywhere now, at least not in this country. The haste for immediate fruition is seen, as I have said, in the production of works in precious metal, for a casket or vase intended for a Royal present is turned out in as many weeks as it would have taken months in the hands of Benevenuto Cellini, and, what is worse, both donors and recipients are satisfied.

It rests with you who really care for good art-workmanship, especially the architects, to bring about a change for the better by personal care and direction, by encouraging the workman who tries to be an artist, by employing him if you are able, or by recommending him to those who can. Patience and forbearance must be shown on both sides; the art-workman who is trying his hand at work in which he is not a past master must not be too exacting about price, and the considerate employer will bear in mind that, though he may run risks through want of experience in the man he employs, he has a chance of getting original work, valuable in itself, and from association far more interesting to him and his successors from the part he has taken in its production or direction, than anything procured vicariously through the ordinary purveyor.

No impetus has been given to decorative art in our time, to compare with that which had its origin some thirty years ago, in dingy Red Lion-square, where a few young men, unknown to the public, but warmed by real enthusiasm, and as the result has shown, led by the light of genius, set to work quietly, and without advertisement, to apply art to industry, with results known to you all, which are associated with the name of, and are in the main due to, William Morris. May our new undertaking be marked by some of their earnestness, and be crowned by success as far-reaching and as beneficial.

DISCUSSION.

Mr. WALTER CRANE said he had some hesitation in offering any remarks after so full and exhaustive a paper, but he gathered that the lecturer pointed pretty plainly to what lay at the bottom of all our difficulties—the system under which we were forced to live. He did not believe that, in any really healthy period of art, the same difficulties had ever been felt. Every child began to draw, and if all had their opportunities probably every one would draw about equally well. Moreover, every one began to draw the figure, for every child found that the most interesting. But that was all crushed out of the student, and he was set to draw corners and angles, and rounds and squares, which

had absolutely no meaning to his mind, and his invention was never set to work. He was carried through all the grades, admirably devised no doubt, and certainly every pains were taken, and it was not the fault of the Art Department that there were not more inventive artists. He had no doubt there was abundance of material—there were as good fish in the sea as ever came out of it—but, somehow, it did not come to the surface, and they sat for hours dangling their rods on the bank, and nothing evei rose. As to the remedy, it was very difficult to point it out. There were glimmerings of hope, and certain improvements might be referred to, but the real impulse which had been given to the art of design was certainly due to the band of men who had been referred to, who began their work in an obscure square in London. They were driven back to the old reason which still stood in the way—the pressure of the times. Even a genuine artist was mostly driven to live by something or other; he was not able to work on the thing nearest his heart, but was obliged to keep two strings to his bow. He must conscientiously do something which might not be contrary to his principles, but which did him less than artistic justice. This fact might be illustrated by a story told of one of our celebrated painters. A friend of his, no less eminent, was said to have asked him why he did not do something really worthy of himself, and his answer was, "My dear fellow, I have eight children." If he had lived in a properly constituted society the artist would have had no anxiety about his children, and would have had full license to do justice to his talents.

Mr. Hunter Donaldson said he agreed entirely with the remarks of the last speaker. In reference to Mr. Armstrong's regret that there was not proper provision for displaying the works of the schools of art, it did seem to him extraordinary that the Albert-hall, which was so often empty, could not be utilised for that purpose, or some other large building might be hired. He believed the British workman, admirable as he was, was inferior on the whole to the art workmen of other European countries in many important branches of art. In ivory carving, wood carving, metal work of various kinds, leather work, marquetrie, silk in combination with metal, velvet, and tapestry work, and many others, the best English workmen were distinctly inferior to the best foreign workmen. You could get in Italy, and certainly in Belgium, ironwork of a much better kind, and certainly at a much lower rate, than in England, which was very much to be regretted. No doubt it was partly owing to the greater cheapness of living abroad, and partly to other causes, but the fact remained that English workmen had not hitherto produced anything equal in quality or in price. This was due to many causes which there was not time to refer to, but the question was, could this be improved? Could you so stimulate the workman as to induce him to become enthusiastic in the art he pursued? Whether there was in the English character that imagination which was essential to all art work remained to be proved, but the English workman had not yet had a fair chance. He was even now struggling against very great difficulties, and, up to a recent period, there had been no encouragement for the development of his genius, but at any rate he had not yet shown that imagination and vivacity which was so commonly associated with the French, Italians, and Belgians, and which resulted in the production of those admirable things which were offered, many of them at extraordinarily low prices. With regard to the influences which might fairly be looked to to effect a reform in art teaching, he thought the Royal Academy was the first. No body of men could do it so effectually, and some day, seeing their obligation to society, and the encouragement they received, they must see it to be their duty to do something. A feeling obtained amongst them that decorative art was inferior to pictorial, and that a high-class decorator was an inferior person to the producer of a picture. This was a fundamental error. There ought to be in the Royal Academy a number of skilful decorators, men of recognised authority, who should direct the decorative art of the country, and to whom all might appeal for the encouragement and guidance which was so much required. Amongst the Academicians there should be a number of recognised teachers of art. What they wanted was, not so much travelling students as travelling masters; men selected for their knowledge of decorative art, to go to great centres like Birmingham and Sheffield, with selections from the South Kensington Museum, and give lectures on ironwork and other branches of artistic industry. What an impetus that would give to the whole art metal trade of the country. The disregard of good art teaching by so eminent a body was one cause why there was such a low standard of decorative art in this country. And this was a time when there seemed less motive for good work than ever before, as the public sought only for what was cheap, not for that which was good, and this acted most injuriously on the workman. He had had forty years' connection with workmen, and knew something of the conditions under which good work was produced, and he was sure that the rage for cheapness was fatal to high class work of any kind. Only that day he was in the show-room of a man who obtained a gold medal at the Paris Exhibition in 1878, and seeing some inferior work there, he spoke to him about it, and he said it was no use making superior articles, for the public would not buy them, and he was obliged to put in his shop things which would sell. The workmen, therefore, wanted teaching, but not more than the employer, who certainly ought to learn what was good work and what was bad.

Mr. Lewis Day was delighted to find that Mr. Armstrong, who had so much to do with the encouragement of art in the nation, was so much in

favour of cultivating decorative art. He did not think it was any use looking to the Royal Academy to do anything in this way, they must look to South Kensington, which there was reason to suppose was doing a great deal of good work; but the question occurred to him whether it was doing as much as one could wish in teaching the application of art. There was now in England a higher level of art than there had been for a long time in the past, but in the application of art it was not so. There were many reasons for this, one being the prestige which attached to picture painting. The only passage in the paper which he felt inclined to take exception to, was that in which the author said that where the sense of decorative art had been great, it was owing to the architect, who ought to have control over all the minor arts. He should like to know what control the architect had over Mr. Morris; in fact, Mr. Morris had jumped upon the architect all his life, and that was the secret of his success. There had been eminent architects no doubt, but they were eminent in spite of that circumstance, and because they had succeeded in developing themselves in some particular direction; and he found that, generally speaking, an eminent architect was abused by all other architects. But decoration was not an architect's profession; in fact, architecture seemed to him to be an impossible art altogether. To be an architect a man ought to be about ten men rolled into one; and if each architect were chopped up into about a dozen, there would be some hope of good work being done. As a decorator, he had had a great deal to put up with from architects; instead of helping him to do his best, he always wanted something in a 13th or 15th century style, and said there was no precedent for what he was doing. When a young man, he did much work for architects, but he had not, for the last ten years, while working on his own account, had anything to do with them.

Mr. Hungerford Pollen remarked that the great historical architects had been something more than mere builders. Such men as William of Wykeham were architects, sculptors, painters, and certainly workers in metal; architecture was more their amusement than their occupation, whereas in most cases modern architects were builders, and became architects from what they found in books. At the same time there were real artists among them, such as Mr. Norman Shaw, whose buildings had real artistic merit. With regard to the South Kensington Museum, he could not forget that France for two centuries might be said to have held the palm for all decorative arts, and the reason generally given was, that there lived there a minister named Colbert, who persuaded Louis XIV. to establish free schools and manufactories—an artistic university in fact—beginning with tapestry, and being enlarged until it included glass-making, lace-making, pottery, and so on; and to this day the French Government, under whatever pressure, always found the means to keep up the manufactory, where not only was art taught, but works of art were produced. Employers of art workmen could there send their men to be instructed, or could select the best workmen, and this was an immense advantage. They had heard that something of the same kind had been done in a small way at South Kensington, by having artists there to teach the making of enamels, and the art of casting in bronze by the "cire-perdue" process, and these were some of the most important steps yet taken there. They could not expect the nation to vote a few hundred thousands per annum to establish factories; but it was very well that even something of the kind was attempted. For some years he was connected with the South Kensington Museum, which was certainly in many departments the finest in Europe, and he used to watch with some interest what it was that principally attracted the British workman and the other visitors. There was at that time a large collection of food products, with the different constituents of beef, mutton, flour, &c., arranged in bottles and saucers, and the greater number of the visitors spent their time in contemplating this collection. He could not help thinking how desirable it would be if the same principle was carried out in respect to art, and some one were appointed to lecture on the different parts of the collection, and point out what it was that gave the real artistic value to the old ivories, enamels, &c., and why some were peculiarly interesting and valuable, and much finer than others of a more showy appearance. It really required a great deal of persuasion to get even educated people to look at these things sometimes. He had heard people admire very much the paintings exhibited on the paving stones in the streets, so that however clever people were, they did not by their mere intellectual attainments attain a love for or knowledge of art. Many people had the most ridiculous preferences amongst works of art; they liked one thing because it was very soft, and something else for some other reason; but did not appreciate the artistic merit of either, or know what it was that made a fine picture. If the Department could employ one of their officers to preach about these things, it would do a deal of good; and if such men were sent into the manufacturing centres, much more good would result. The British workman was intelligent, and would take it in as quickly as anybody; and he hoped Mr. Armstrong would see his way to carry out the idea in some way.

Mr. Wardle said his impression was that they were starting on a new campaign, and it was yet too early to dogmatise much. By-and-bye they would know more of their shortcomings and aspirations, and would be able to direct their efforts accordingly. He believed the starting of that section would be productive of much good. If it helped to draw together those who were willing to work for the purity of art productions, and if it brought them in connection with those who wished to possess such

articles, great good would be attained. If those who were employed in decorative art, however humble, were appreciated and personally recognised, this would approximate very greatly to the advantages which pictorial artists derived from the Royal Academy. Decorative art was certainly subordinate, but it was a fortunate thing that in every house and cottage in England decorative art found a place. The love for ornament was universal; it was not necessary that decorative art should be costly, but it ought to be genuine; and there was a great future before it.

Mr. E. C. Robins said that, being an architect, he felt some diffidence in speaking after what had been said; but he might remark that his experience of decorators had been rather favourable, and he had found them of immense assistance to him. He did not pretend to be a universal genius, who could direct every kind of artist in whatever branch he had taken up, and it seemed to him that what was wanted in architectural education was specialism, and that was growing every day. There was not enough building to employ all the architects, and some were turning their attention to different points, such as ironwork, designing tiles, or anything in fact which required a knowledge of the different styles prevalent throughout the world. The peculiarity of an architect's education was that it taught him proportion, and led him amongst scientific men. He had a way of looking at things different rather from the freehanded artist, who was not bound at all by geometric thoughts in his construction. It would be generally admitted that the basis in most ornament was geometrical; nature itself was geometrical, and therefore there was a great preliminary good in the fact that an architect had associated his mind with those strict forms which underlie everything beautiful. A knowledge of styles was also essential. As a schoolmaster shivered when he heard a false quantity, so did an architect when he saw an anachronism in decoration. It was very painful to a man, when he had designed a building with great care in the 13th century style, to find decoration put into it that belonged to the Renaissance. As an illustration, he might refer, as he had done before, to the room they were in. The house was built by Adam, and when he was asked to superintend the decoration, &c., he searched through the works published by Adam to see what style he adopted, and then he and Mr. Crace, the decorator, studied the matter together. Books had been spoken of rather slightingly; but where could you find these things except in books? The art library at South Kensington was one of the finest institutions in the country. Architects felt the want of education as much as any one else. When he was a pupil he attended the school at Marlborough-house to learn freehand drawing, and was very much annoyed that he was not admitted to the class for modelling because he had not been there long enough. He had always thought since that there should be a little more freedom in the regulations—that there should not be one uniform routine. It would be well also if classes were established at South Kensington for higher grades as well as lower. Everything in this country was done for working men; but the difference between us and foreign countries was not in the workmen, but in the next class above—in the masters of the workmen. If they thought more of teaching the pupils in architects' offices, and students in artists' studios, and in every kind of trade, there would be someone to direct the workmen—the masters would know how to direct them; they would be in fact art-teachers, and better work would be done. It was quite true that architects were very ignorant in many matters they had to direct; but if an architect did not understand glass work, it was folly for him to attempt to design it. The secret of success was for a man to know his own weakness, and supplement his own deficiencies, so that everything he turned out should do him credit.

Mr. Vincent Robinson said there was a great need for the application of the arts in this country, but what particular direction the movement should take did not seem quite apparent at the moment. Certainly it should take a more practical form, and should be extended to adults as well as to young persons. Whether it could be done by the Royal Academy might be questioned, but it seemed to him that some guild or institution, which should grant a diploma to a skilled artist, would be one means by which the gulf between the artist and the artisan might be bridged over. The artist was too theoretical, and the artisan not sufficiently skilful. All would admit that South Kensington had been of immense service to the country, but it was doubtful whether it had not as yet developed critical rather than creative faculty.

Mr. Phene Spiers said there was one point to which he would like to draw Mr. Armstrong's attention. Some three years ago, drawings from all the schools of art in England, and also from foreign schools, were exhibited, with descriptions of the methods employed, so that the jury who inspected the foreign schools could see whether there was any thing in them worthy of introduction. There was one system, either Belgian or German, which made a strong impression on him. In training masters for that school, it was not considered sufficient to pass certain examinations, or to submit certain drawings, but an examination was made of the critical powers of those who were to become art teachers. There was a *viva voce* examination, in which the candidate was shown certain drawings, and asked to pick out what he considered the best, and give his reasons for the choice. This occurred to him when a previous speaker referred to the advantage to be derived from sending down art teachers to lecture in the country. If any man showed a specialty for a particular class of design, his powers of criticism in that branch should be developed and tested, for one of the great

difficulties in all art schools was that the teachers themselves had not been taught how to criticise, and to point out why one thing was wrong and another right. Many art students went to France to finish their education, because when in the Academy, though they had eminent painters as visitors, they only came a month at a time, and the student, after listening to one man for a month, was criticised by another man who might go on a different line altogether; and so he got confused. In a French *atelier*, generally speaking, the professor had been through all the courses, and had all the elements of criticism at his fingers' ends. He would also insist on another point which had been mentioned, that the English public would not give the price they ought to for really good work, though they would pay an enormous sum for an ancient piece of furniture, simply because of its age, without knowing whether it was good or bad. They did not seem to care for design, or even good workmanship in modern articles, but would have something cheap.

The CHAIRMAN congratulated the meeting not only on the great excellence of the paper but on the interesting discussion which it had elicited, although the main result of the latter was to demonstrate how hollow was the criticism which had so often been directed against the Science and Art Department at South Kensington. He could not speak too highly of Mr. Armstrong's paper for the width and thoroughness with which it was written, and the admirable good nature which characterised it throughout. He had never listened with greater pleasure to the reading of any paper within these walls; and he was sure that the vote of thanks he had to propose to Mr. Armstrong would be carried by acclamation.

The vote was carried unanimously, and the meeting adjourned.

EIGHTH ORDINARY MEETING.

Wednesday, February 2nd, 1887; Captain DOUGLAS GALTON, C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ballard, William Washington, 46, Bedford-row, W.C.
Bell, Edward, 4, York-street, Covent-garden, W.C.
Drower, John Edmund, May Trees, Endlesham-road, Balham, S.W.
Hodgson, Shadworth Hollway, 45, Conduit-street, W.
Longden, John Needham, 9, Castle-street East, Oxford-street, W.
Narayana, Lakshmi, Panjab, India, and 49, Chesterton-road, W.
Smith, J. Hatchard, 41, Finsbury-pavement, E.C.
Thomson, W. Stewart, M.A., The Aberdeen Preparatory School, 10, North Silver-street, Aberdeen.

The following candidates were balloted for and duly elected members of the Society.

Beamish, Major A. A. W., R.E, 28, Grosvenor-road, S.W.
Blomfield, Reginald T., M.A., 39, Woburn-square, W.C.
Brevitt, Horatio, The Leisures, Tettenhall-road, Wolverhampton.
Coates, William Thomas, 24, St. Martin's-road, Stockwell, S.W.
Crow, Arthur, Ely-house, Carnarvon-road, Stratford, E.
Docwra, John William, Clumber-house, The Ridgeway, Enfield.
Geen, Charles, Hillside, Okehampton.
Graveley, George, "Cheops," Cambridge-park, Wanstead, E.
Gray, Edward James (Alderman), 37A, Mincing-lane, E.C., and The Hermitage, Snaresbrook, E.
Hamilton-Gordon, George William, 72, Finsbury-pavement, E.C., and The Close, Salisbury.
Hammond, Charles Pollard, 28, Warwick-street, New-cross, S.E.
Haynes, W. H., 135, Alexandra-road, N.W.
Heald, Simpson C., Worcester, Massachusetts, U.S.A.
Hope, William, 32, Park-lane, Liverpool.
Hunter, John, 17, Richmond-villas, Holloway, N.
Isaac, Frederick Simeon, 28, Queen's-gate-gardens, S.W.
Laycock, William Samuel, Rosemount, Ranmoor, Sheffield.
Lean, Alfred E., 46, Birdhurst-road, Wandsworth, S.W.
Little, Matthew, 18, Thurlow-road, Hampstead, N.W.
Price, Samuel Thomas, 23, Sansome-st., Worcester.
Ross, William, North Wall Ironworks, Dublin.
Sheppard, James, 19, Bennett-park, Blackheath, S.E.
Stanley, William, junr., Great Barrington, Massachusetts, U.S.A.
Stone, J. B., J.P., Sutton Coldfield.
Sutton, Thomas, 22, Salthouse-road, Barrow-in-Furness.
Walker, Sydney F., 195, Severn-road, Cardiff.
Waller, Thomas M., Consulate-General of United States of America, 12, St. Helen's-place, E.C.
Yarrow, A. F., Ardmore-house, Blackheath, S.E.

The paper read was—

UTILISATION OF TOWN SEWAGE BY IRRIGATION.

By ALFRED CARPENTER, M.D., M.R.C.P.Lond.

Allow me to thank the Council for having given me this opportunity of stating the case of sewage irrigation, in accordance with my

request. I made that request immediately after I had read Dr. Tidy's paper upon the treatment of sewage. Having read the abstract, I considered it a veiled attack upon the principle of sewage irrigation which required a specific reply. When I read the paper upon which the abstract was founded, I could only wonder still more at the reasons for attacking the principle I advocate in the terms which are set forth by Dr. Tidy. My paper is, therefore, an answer to the charges against sewage irrigation which are contained in that paper and report.

It is not my intention to analyse the figures submitted by Dr. Tidy in his very exhaustive paper. I value it very highly, and if it had not contained the decided onslaught that he makes against irrigation, I should have only had praise and thanks for his work; indeed, I shall quote it in this paper, and use his facts in support of the principle which I advocate. It is of supreme importance to the interests of our nation at this particular juncture. I take Dr. Tidy's own figures in connection with those facts, and the estimated value which he places upon London or town sewage of 1¾d. per ton, which is, in the aggregate, a higher value than I have been accustomed to assess it. He says:—"I think you may take it that 8s. or 9s. is more nearly the actual result than any other figure that I (Dr. Tidy) can arrive at." He is of opinion also, most decidedly, that the chief manurial value of sewage is in the urine, which he places at "from 6s. 8d. to 7s. 6d. per year for each adult." I am content to take his estimate of the value of both solids and liquids, though in my reckoning I have only taken it as equal to the manurial value of one sheep—that has been put at 5s. by eminent agriculturists, who drew their inferences from actual practice. I am content to take it as a figure easily reckoned. That sum is capable of being obtained from ordinary town sewage, if scientific supervision is practised upon a sewage farm; that is, a return of £25,000 a year is capable of realisation from the sewage of 100,000 people when properly applied. On this low calculation, at least £5,000,000 a year is lost to the nation by present customs. Let me, however, guard myself at once from misunderstanding. I do not assert that £25,000 a year is the profit which is to be realised, any more than a farmer, when he states that he has obtained ten or twelve bushels of wheat to the acre, means that such a result is all profit. This is the rock upon which sewage chemists and sewage doctors have been wrecked—they have assumed the result to be profit to the operator. It is no such thing. There may be no actual profit to the farmer upon the whole working of the farm, if he has to pay an exorbitant rent for it, and high wages to his servants. But there is another side to the question. If he grows so much produce from the land, the production of the food must be a benefit to the country, though it may not directly profit the individual. If £25,000 worth of produce is raised from a given area, which under other kind of cultivation cultivation only raise £5,000, or at most £10,000 of produce, it must be a manifest advantage to the State. That is my point. Let me put the case broadly to start with. An acre of ordinary land, under ordinary cultivation, may show £10 as the result of fair farming. If artificial or other manures have been used upon the land, the cost of such applications must be deducted from the total value of produce, as being caused by outside influences. A thousand acres may show at the outside £10,000, as the annual outcome of farming in ordinary and average country places. Now-a-days, farmers have to be content with a lower figure than that. I contend that 1,000 acres under proper sewage farming will have no difficulty in showing a return of £25,000, if it be managed upon correct principles as a sewage farm, and the country is enriched in consequence to that extent, though the municipality utilising the sewage may not get any actual profit upon the transaction, because other charges swallow up the proceeds.

It was my privilege to take part in a Conference upon the sewage of towns, which was held in Leamington on the 25th and 26th October, in the year 1866, under the presidency of Lord Leigh. At the end of the reading of papers and discussions, lasting two days, a resolution was carried unanimously, to the following effect:—

"That this Conference is of opinion that the system of irrigation, when carried out in a scientific manner, removes the difficulty which arises from the present noxious plan of polluting the rivers of England, but that there are circumstances in which other systems may be applicable, and that this Congress considers that no system can be laid down which shall be suited to all towns."

I had the privilege of moving the first half of the resolution, which was accepted by the larger portion of the meeting, but then, as

now, there were chemists, patentees, and would-be company-formers, who, whilst unable to resist the evidence afforded at that time in favour of broad irrigation, were not to be turned from their own views, and I accepted the second part as a rider to the first, for the purpose of securing an unanimous adoption by the assembly.

A further experience of twenty years, partly in superintending a large sewage farm, more lately in watching the work of others, has satisfied me that the experience which had been gained in 1866 has been fully borne out by more recent operations. My paper at that Conference was styled, "The Successes and Failures of the Croydon Local Board." I did not then, as I do not now, fail to recognise the enormous difficulties under which the subject of sewage utilisation is placed, because it is so intimately connected with the liberty of the subject, with popular fallacies, and with local self-government. A benevolent despotism, or an autocrat with complete personal and Imperial power, would have settled this question long ago, to the manifest advantage of this kingdom as a nation, especially to the great advantage of the meat and milk consumer, and to the taxpayers in general, however much it might have apparently added to the indebtedness of the individual locality. It does not follow that a people is made poorer by such an indebtedness. The money paid by France to Germany, after the last Franco-German war, was thought to be a tremendous weight upon the shoulders of the French nation. It is now a source of wealth to the latter people, and assists them to bear the taxation imposed in consequence of it almost with impunity. So also the loans raised in localities like Croydon, which will be paid off in fifty years from its foundation, will then leave a magnificent estate to the ratepayers, which will assist to materially mitigate the incidence of local rating in our particular locality, and the borough, as well as the country, will be correspondingly enriched by the transaction.

I am not going to say a single word against any of the rivals of broad irrigation. I am quite as ready to accept the rider to the Leamington resolution as I was twenty years ago, but I am still more satisfied than I was then that there are few towns in which broad irrigation is not applicable, and that the plan adopted by towns on tidal rivers and seaboards, in turning their sewage into the sea, is unjustifiable, is unpatriotic, is selfish, and contrary to correct principles of political economy. It ought, in consequence, to be strictly prohibited by Parliament as an addition to that Act which is now beginning to cause to cease the pollution of the rivers by inland towns.

I will now return to Dr. Tidy's paper, and taking his framework as my skeleton, I will deal with the fallacies contained in it in my remarks upon the general subject. He acknowledges that commission after commission has been issued for the purpose of inquiring into the "Sewage of Towns." Select committees have also been held, and in most, if not in all cases, reports were made by men eminent as chemists, as engineers, and as agriculturists, distinctly in favour of irrigation for the purpose of dealing with town sewage, and numerous committees of the Houses of Parliament have reported in its favour.

Dr. Tidy divides his subject into four heads:—

1st. The method of applying sewage to land.
2nd. The soil best suited for irrigation.
3rd. The crops most suitable for a sewage farm.
4th. The value of the crops so grown.

1st. The method of applying sewage to land is, to my mind, of the greatest importance. Dr. Tidy scarcely touches upon this part of his subject, and in avoiding its consideration, leaves his foundation insecure. If sewage arrives stinking, if it comes into the carriers like a mixture of ink or dark coffee, and full of floating particles of confervoid growth, the local authority is in fault. The solids in the sewage are of very little value. Dr. Tidy puts them at about 1s. 2d. per head per year. That may be their value, perhaps it is rather greater than that sum, if the fæcal evacuations are brought on to the farm in a fresh state; but if twenty-four hours are allowed to elapse in warm weather, or forty-eight in cold seasons, before the solid reaches the soil, it is worth less than nothing, for it has, assisted by the bacterial life which it contains, robbed the sewage of a large portion of its fertilising power. A sewage farm, to be pecuniarily successful, must have the sewage delivered in a fresh state, before any kind of fæcal fermentation has been established, before the so-called sewage weed shows itself in the running sewage, and before any sooty kind of matter has blackened the liquid. Sewage leavened with this matter, which has been three or four

days in some enormous culvert, or some defective sewer, rapidly depreciates in value, just as a piece of the vinegar plant put into the brewer's sweet wort and allowed to remain for a few hours will effectually prevent his obtaining the alcohol which he expected from his vat. The *sine qûa non* of successful sewage farming is, therefore, that the sewage be delivered fresh upon the land to which it is sent; this involves a correct form of sewer in the locality which furnishes the sewage. Secondly it must be delivered on an intermittent plan. To irrigate a field of forty acres with sewage for several days in succession, to allow the sewage to flood the land, and remain above the soil, so that all air is removed from the soil, for sometimes a week, or even, as I have seen it, for nearly a month at a time, is certain to lead to financial failure, and to seriously diminish the power of the soil to deal with the fertilising matter contained in the sewage. Sewage does not contain free oxygen. A river into which crude sewage is discharged will lose all evidence of oxygen in its gases, if the volume of the sewage is equal to, say, one-fourth that of the river water. So that when that stage is reached, the fish die for want of air. So also without oxygen in the subsoil of the farm utilisation of sewage cannot go on, for the combinations which are required for the continuance of plant growth render oxygen as necessary as it is to animal life. It is true that the function of the plant is to decompose the carbonic acid and of the nitrogenous juices in the sewage into simpler elements, yet such changes cannot go on without oxygen; and if carbonic acid is too abundant in the subsoil, and oxygen is altogether absent, the vegetable growth is more likely to be damaged than helped, the oxygen set free is not discharged into the subsoil, but in the air above the ground. Sewage must be mixed with oxygen obtained from the atmosphere; as a consequence, therefore, it is most important that sewage application should not be for than twelve hours at a time in warm seasons, and twenty-four or thirty-six in the colder parts of the year. This sewage must pass over the surface of the soil, and not sink into it more than twelve or eighteen inches deep. The carriers should not be too wide apart, neither should they be more than three to six or eight inches deep, in their final distribution upon the land; any kind of moveable troughs of wood, sheet iron, or any other material, are quite out of place, except for the purpose of carrying sewage over a short valley, or over other carriers which may happen to be at the lower level. The carriers should be simple trenches in the ground, the bottom of the trench being slightly above the level of the soil, so that the sewage after passing into the carrier should well over on either side, and run down to the pick-up carrier, which should be parallel to the delivery carrier, but not in close proximity; thus the carrier delivering the sewage will cease one-half or two-thirds of the way down, and the pick-up carrier will commence at the middle, and go on to the bottom of the field, delivering into a deeper cutting in the subsoil at the lower end. The passage of the sewage must be superintended by the waterman, who must watch the delivery, and by stop-boards judiciously placed, keep the sewage spread equally over the soil, and at the end of twelve or twenty-four hours take it off that particular field and place it on another. The first field should be so levelled that it must be completely free from evidence of sewage upon its surface six hours after the water has been taken off. The water should run away by the lower pick-up carrier, and fresh air will then enter the interstices of the soil as the water drains off from the field. It is altogether a mistake to insist upon under-drainage, unless in special portions, in which the water cannot otherwise be cleared away, or where, from narrowness of area, it is requisite to supplement the farm by intermittent downward filtration. It will be found from practice that a well-irrigated land must and will clear itself in the way I have indicated, if the result is to be satisfactory, and no results from other lands ought to be taken count of.

I have seen a considerable number of farms laid out in a mistaken manner, to begin with. The carriers delivering the sewage have only emptied themselves of half, or even of only one-third their contents, keeping the lower half, or two-thirds of the carrier, full of sewage in a stagnant state, losing its fertilising value, and assisting in developing a stink, in positions in which such a thing should be impossible. It is much worse in those carriers which have concrete bottoms, because there is no soakage at all into the soil below. Main carriers should in all cases deliver the sewage on to the field from the lowest part of the semi-cylinder, so that no stagnation should be possible in the carrier itself. It is simply a question of levelling and first outlay. The delivery carrier on the field should allow of soakage in the soil, the main

carriers should not. The pick-up carriers will be found, in the course of time, to allow of percolation through their sides, whilst their bottoms will be scarcely pervious to the effluent, which should get rapidly away to the outfall.

There must be no departure from the principles here inculcated if we are to get a good financial result. Fresh sewage does not smell offensively, it is scarcely coloured, certainly not black or opaque, and when delivered it must not be retained in badly constructed carriers. It must not be poured on to the same patch of ground for more than twelve to twenty-four hours at one time, and the effluent must escape from that ground within six or twelve hours of its delivery upon it. Immediately the delivery of sewage upon the patch is stopped, the carrier should run off clear, and be flushed so that no deposit should be allowed to remain at the junctions or within the pen-stocks which are necessary to allow of a command over the distribution. Let these conditions be carried out, it will be utterly impossible for any more mischief to arise from the distribution of sewage than arises in every house when a person uses the water-closet belonging to his own establishment. It takes at least twenty-four hours for mischief to develop from fæcal fermentation, and if that time is not allowed to intervene, and the constituents of the sewage are brought into contact with plant life and the ordinary chemical constituents of agricultural land in the way indicated, no dangers such as Dr. Tidy considers to be necessary parts can possibly come from sewage irrigation. That is the kind of irrigation I advocate, and any other is manifestly wrong.

I now come to the second head, viz., "The soils best suited for sewage irrigation." Dr. Tidy has misunderstood the object of the operation. That there is an immense advantage in the presence of ferruginous earth upon a sewage farm, if the object of the managers be simply to purify the effluent, goes without the saying. To purify the sewage has hitherto been the main object of sewage farm managers, but it ought not to be their primary point. The primary point should be—given so many tons of sewage, containing so many lbs. of nitrogen, or so much ammonia, to obtain from the cultivated lands so many tons of produce in exchange. A non-retentive soil, a fine or coarse sand, will require a different kind of cultivation to that which contains a larger proportion of clay. The carriers must be arranged somewhat differently, not be so far apart, and the ground need not be broken up again so frequently as must be the case when an argillaceous soil is at hand. Chalky and marly soils are of great advantage, but they require to be broken up more frequently than sandy soils, if there is to be a large pecuniary result. It is a matter, therefore, of cultivation rather than one of advantage and disadvantage in character of soil. It is not filtration which is to be looked for, not the chemical alteration of sewage products into harmless elements, such as arise when ferruginous earths abound; but the abstraction of the dissolved albumenoid and ammoniacal matters from the sewage itself, and their conversion into vegetable produce at the earliest possible moment. "When the effluent is turbid and discoloured,"—I use Dr. Tidy's words—the manager may have been at fault in applying the sewage wrongfully. At the same time, I am bound to state that it is utterly impossible to get an effluent which shall be at all times bright and clear. Let an ordinary meadow be flooded with pure water just after a hay crop has been taken from it, and there will be a coloured infusion of hay or other vegetable matter flowing from the field, which no art can easily prevent. If the soil has been recently broken up, the first discharge of effluent will be turbid and discoloured, but it will be with material which is comparatively harmless, and it is not sewage. Such is also the case after the carriers have been recently cleaned, or if cattle have been trampling on the carriers and chewing the cud in the running stream; but that result does not condemn sewage farming any more than Providence might be condemned because a clear river is made turbid by a thunderstorm. Sewage farming requires great judgment in application of the dressing. No hard and fast line can be given except the one point to which all managers should be obliged to conform, viz., if so many tons of sewage are used upon so many acres of land, let the land be what it may, so many tons of produce should be obtained from that land within twelve months of its application.

Dr. Tidy made a great point of the effects of frost upon sewage utilisation. His remarks showed that his imagination had got the better of his experience, or rather that his experience of the effects of frost upon sewage irrigation was absolutely nothing. The sewage, as delivered from a sewer in winter, has a temperature of some 44° or 48°, according to the presence or absence

of snow water in the delivered sewage. I have never found it lower than 44° in temperature, even in severe frosts and after heavy snowstorms. As it flows upon the land, whatever ice or snow may be there is melted, and it spreads over the field even in severe frosts in a perfectly natural manner, just as the River Wandle, near to our town of Croydon, never freezes in even the coldest winter, because the springs which rise in it from the chalk formation are always warmer than the surrounding atmosphere, never falling to a lower temperature than 45° in the coldest winter. The quantity of sewage delivered is also much smaller than in milder weather, and it is probable that the percentage of hot water going into the sewers is also increased. As a consequence no difficulty is found to exist upon a sewage farm during frosty weather. If a coating of ice does form upon an irrigated field after irrigation has ceased, the ice protects the rye grass from damage from the cold winds which usually occur at such times. Vegetation goes on below the covering, a considerable portion of the material in the sewage is picked out by the living plant, and a field of young rye grass—after the ice covering has disappeared, and a warm day or two comes to our aid—shows a most wonderful activity. The sewage farmer is able to cut a crop of green food almost before an ordinary farmer has the opportunity of seeing a tuft of young grass in any of his unirrigated meadows. I do not mean to contend that there is no difficulty in frosty seasons. A clay soil is not then so advantageous as a sandy soil or a ferruginous earth; but because a temporary difficulty has to be contended with, especially if the area is small compared with the population, that is no reason for condemning the farm; an ordinary farmer is in similar trouble. But if the area be large enough, there is no more difficulty than belongs to a railway in a fog; it is a reason for care, not a reason for condemning the use of the railway altogether. This is the mistaken idea which runs through the major part of Dr. Tidy's attack upon sewage irrigation. Difficulties belong to all scientific operations; they must be guarded against and their effects obviated, and it ought not to be an Englishman's custom to give up the contest if the ultimate result can be shown to be a satisfactory one.

Dr. Tidy asserts that, although the soil may be a purifying agent, it is, to say the least, capricious. That is, Dr. Tidy acknowledges that he does not understand the principles which Dame Nature pursues in dealing with the agricultural use of sewage, and, therefore, he cannot recommend them. The purifying power of a soil is no doubt peculiar. Its peculiarities must be found out, and it will then be found as amenable to management as when an ordinary farmer finds out how much more satisfactorily he can cultivate his soil if he can follow a proper and systematic rotation of crops. The point to be aimed at, therefore, is to calculate the amount of material put on to the surface of the farm; let us say 5,000 tons of sewage per acre per year, this equals 1,200,000 gallons. Let us take Dr. Tidy's value, $1\frac{3}{4}$d. per ton, it becomes necessary to obtain from that acre of land, in the course of the year, about 40 tons of produce, either of roots or green crops, and the pecuniary result should be not less than £44 5s., upon Dr. Tidy's figures. Any sewage farmer will acknowledge that there is no difficulty in doing this, if the ground is irrigated with fresh sewage. It repeatedly happened, whilst I was superintending the Beddington Sewage Farm, that some of the least retentive fields were supplied with 10,000 tons of sewage per acre, and our returns from those fields were considerably more than 40 tons of produce, nearly double that quantity being obtained sometimes. It is only when the sewage is allowed to stagnate before it gets to the land, or is allowed to go on a particular plot for too long a period at one time, that the results are not satisfactory, for the reasons I have already stated. Dr. Tidy speaks of water-logged areas. The area which took its 10,000 tons of sewage per acre was never in any such condition. The quantity of sewage going on to the land only corresponded with the rainfall as it ordinarily occurs in some parts of our Lake districts, and no one frequenting the Cumberland valleys can fail to see how beautifully the meadows dry themselves after the heavy rainfalls belonging to that locality, without any under drainage; and that the grass of the district is especially satisfactory for stock keeping, never putting on any of that dropsical appearance which Dr. Tidy has pourtrayed as the habitual produce of an ordinary sewage farm. It will be seen that in the fields to which I especially referred, each acre of land received the sewage of about 125 persons; if I take the value of the sewage of each at 5s. per head, the amount to be obtained works out to the same figure, viz., about £31 5s. per acre. Five crops of rye grass, at an average of 1s. per rod per cutting, will produce £40, and I have

repeatedly seen 40 tons of mangold wurtzel per acre, which has sold at from 18s. to 24s. per ton, according to the season. When such results follow upon the application of sewage to the land, that land, whatever may be its character, will have the larger portion of nitrogenous matter which the sewage carried to it taken out of it again. It will be utterly impossible for any of those contingencies depicted in such alarming language in Dr. Tidy's paper, to show themselves in anything else than in the imagination of the people and those who try to mislead them upon this important subject. I am obliged to Dr. Tidy for quoting Voelcker's experiments on the action of various soils upon ammonia, especially that part which shows that the weaker the ammonia solution is, the larger the relative quantity of ammonia absorbed; and that the quantity capable of being removed by washing with water is relatively less than that retained by the soil. I take this fact as a strong argument in favour of the application to land of weak sewage, such as town sewage generally is. Such is the application of ammonia to soil which nature provides in an ordinary rainfall, rather than in the form of patent manure, which finds so much more favour with a certain class of chemists, and with the antagonists of sewage farming. I cannot follow Dr. Tidy in his statements, based upon Dr. Voelcker's experiments, that the total soluble nitrogen may be found in the effluent as nitrates and nitrites. I cannot conceive it possible that any well-regulated sewage farm has ever shown an effluent in which the same amount of organic constituents were found as were contained in the sewage, and when chemical examination has shown this, the effluent is not from a sewage farm, unless it be an intermittent filtration area. I do not doubt Dr. Tidy's or Dr. Voelcker's figures, but I doubt the source of the effluent. When a sewage farm is simply a filter, oxidising the nitrogen in the sewage, and acting as a strainer for the coarser particles, it is no more a sewage farm than a town tramway is a railway fit for the "Flying Dutchman" to travel upon. It would be curious, indeed, if our railway engineers were to suggest that, because a splendid engine cannot travel on a metropolitan tramway, therefore railways should be abandoned as dangerous, and unfit for introduction into populous communities. Dr. Tidy gives support to a principle I have advocated for many years, and I take advantage of his chemical knowledge on this subject. I am not a chemist, and I know in that department of the subject I have a safe platform to rest upon in any analysis he may have actually undertaken and published. He says that the composition of irrigated, as compared with non-irrigated soils has been the subject of numerous investigations. The top few inches of an irrigated farm presented marked difference from the underlying soil. "If, however," says Dr. Tidy, "the top inch of the land be carefully scraped off, the difference in the composition of sewaged and non-sewaged ground will probably be found to be small. At the depth of eighteen inches it is a very rare thing to find any marked alteration of composition. It is certain, therefore, that, given land of ever so suitable a character as a sewage purifier, its powers are not agriculturally those of a storage battery." My experience coincides with Dr. Tidy's chemical examinations. It is better to provide for the sewage passing over the surface, or for being dealt with near to the surface, than to attempt to underdrain in hopes that the water will be purified and carried off more satisfactorily. No doubt intermittent downward filtration may be of use in confined areas, and during long continued frosts, for temporary relief, but it is not the primary object which a sewage farm has in view. We do not want a storage battery, except in the way described by Dr. Voelcker as the result of the applications of weak solutions of ammonia to ordinary soils, and then only for the darkest parts of the winter season. At other times the soil must be made to deliver up in a rapid manner to vegetable life the nitrogen which has been abstracted from the sewage, whilst, in the warmer seasons of the year, the organic constituents of the sewage should comparatively not come into contact with the soil at all, but should be at once seized upon and digested by the carnivorous plant, which deals with it as satisfactorily as the anemone deals with organic matter contained in sea water in the pools of any of our rocky shores.

This brings me to Dr. Tidy's third head, viz., "The crops most suitable for irrigation." Our author does not offer any opinion upon this point; he quotes the opinion of others. He says nearly all "agree that the most profitable application of sewage is to pasture land, osiers, and Italian rye grass." He quotes the statements which have been made regarding the fondness of cattle for sewaged grass, and describes cattle as immediately following upon the application of sewage to land, and eating with avidity the

grass still wet with sewage. This ought not, and could not be possible on any farm of which the manager knew his duty and understood his work. It is no more argument against sewage farms than it would be against a railway, because a gate being left open, the cattle strayed upon the line and were killed.

Dr. Tidy's story of the Aldershot cabbages is only hearsay evidence, and, if true, only showed that the farm manager did not know how to deal with his crop. If he sewaged them a day or two before cutting the cabbages, the story is a possible, nay, even a probable one, for the outside leaves would be soaked with sewage water. But cabbages or roots ought not to be sewaged for at least a month before the crop is ready for gathering, and no rye grass should be sewaged for at least a week before it is ready for cutting; then the conditions described could not come to pass.

I will now give you my own experience as to the proper crops for a sewage farm. They are simply rye grass and roots, with a crop of cereals once in six or seven years, and whilst cereals are under cultivation no sewage should be applied to the land at all. The soil having been prepared, as I mentioned in describing the character of the carriers and the pickups, it should be sown with rye grass in the early autumn, so that the young plant may be fairly developed before the frosts of winter set in. It may be treated as I have described—with 5,000 tons of sewage per acre per annum. It will enable the managers to take at least five crops off that field in the ensuing year, and if the season is a warm one, sometimes six or seven. Sewage farmers sometimes ignore the fact that rye grass is a biennial, not a perennial plant, and that if it be allowed to get well into flower, it will cease to provide more green material, and the sewage will not be purified to the extent that would be the case if the plant be cut as soon as there is the slightest appearance of flower in the field. If this treatment is steadily pursued, the cropping may go on for two years, or even for a third year, but that is all. If, however, the rye grass be allowed to go into flower, the field will be useless for next year's work. I have seen a farm of 200 acres of rye grass with 150 quite useless for the purpose, because the managers had cut off the demand for grass by absurd arrangements, and as they could not sell it, they would not go to the expense of mowing, and allowed the whole crop of the ensuing year to be entirely lost by seeding. The local authorities who were managing the farm at that time were also paying £10 per acre as rental for that land. It was no wonder that, with such management, the financial results were unsatisfactory, and the effluent not so pure as it ought to have been. Under the plans I have pointed out as the right principle to be adopted, I have known twelve tons of grass to be taken from a given area, and within one month afterwards a similar amount from the same plot, but this was when the season had been continuously warm. I should be fairly satisfied with an average of eight tons per cutting per acre.

Why do I prefer rye grass? Because it is a carnivorous plant, digesting the animal matters presented to it just as Darwin has described the action of the Drosera, or Sundew, upon the poor little fly which is caught in its embraces, or the action of the Amæba upon the organic remains which it may have surrounded in its outer membrane, turned for the occasion into a stomach. The plant acts at once upon the material without it being necessary for the organic matter to be reduced to lifeless salts before it is assimilated. I am bold enough to differ on this point with one of the greatest chemical authorities of our age, viz., Liebig. I do so because I watched some years ago, with some interest, the action of various juices upon growing plants. I planted rye grass seed in well washed sand, and kept it under glass receivers, feeding one series of plants (after growth consequent upon pabulum in the seed itself, had ceased) with simple distilled waters, others with milk or beef tea in weak solutions, others with fresh urine, others with stinking sewage, others with solutions of salts, which would represent the quantities of those materials contained in the various organic or animal juices that I used. Those fed with distilled water remained all but stationary; those fed with fresh milk, fresh juices of meat, and other unchanged animal substances, grew much more rapidly than those fed with the nitrate of ammonia and phosphate salts. There was a marked difference between the sets of plants at the end of a week in favour of the fresh organised material, though in all other circumstances they were treated precisely the same. It appeared to me as if the carnivorous plant was able to assimilate the animal juices much more immediately than the other matters, whilst those fed with stinking sewage did not grow at all in the time, any more than those fed with distilled water, and those treated

by phosphates and artificial manures required more time to assimilate the material supplied to them, and at first grew more slowly. From the result of these experiments I am of opinion that it is not necessary for organic material to be reduced to its simple elements, and turned into ammonia and phosphatic salts before the plant can assimilate the material presented to it. It was apparent that if fermentative changes had began, there was delay in assimilation; I account for that delay by the time required by the micro-organisms contained in putrefying sewage to complete the work of disintegration in which they are engaged. The process of assimilation was in that case slower than when the material was ready, as organised matter, to be absorbed and fixed in the tissues of the plant. It is acknowledged that there is no known chemical difference between the albumen and the fibrine of vegetable matter as compared with that of animals. It appears to me that it would be a clumsy process if nature had to disintegrate matter into its original non-vital elements for the purpose of returning it to a similar organised state again; but I can understand that it is necessary, when the disintegrating process has began in consequence of the activity of bacterial life, for that disintegration to be completed before the vegetable cell can deal with the matter presented to it. In fact, some of the plants fed with stinking sewage, in which putrefaction was not complete, did grow more rapidly than others, and I impute this to the probability that the plant fed upon the bacteria in the stuff, not on the salts. It is in the power of vegetable cell life to deal with fresh sewage in a more rapid manner than it can with that which is already putrefying, which is the keystone to success in sewage farming. It is the principle which local authorities must attain to if they wish for good financial results. When local authorities, therefore, complain of a decided loss upon sewage operations in a balance sheet (excluding engineering difficulties), and whilst acknowledging to the efficiency of irrigation in preventing river pollution, they are most likely allowing bacterial or fungoid life to destroy the fertilising power contained in the sewage, and delivering it in stinking condition upon the land. But, as I have said before, these are no reasons for abandoning sewage irrigation, because it has been repeatedly shown that the application of stinking sewage to land is not a part of the process to be entertained, and it is not a part of correct sanitary organisation to allow sewers to exist in a town as sewers of deposit.

I think that osier beds, as a part of the cropping of a sewage farm, are a mistake. Such beds may be planted in situations which cannot be kept properly dry, by reason of its being the bed of an old pond, or an old watercourse, or because it is invaded by effluent, but to lay out a farm with osier fields would be sanitarily a mistake. Osiers make good borders to sewaged fields, as belts around them, but they should only be used for protection, not for the absolute utilisation of sewage, for it is impossible for them to produce the weight of crop required. So also with ordinary grass or meadow land. It is very well to have meadows capable of being sewaged when there is excess of storm waters, or when the effluent, having been applied to a newly prepared plot, is not so clear as could be wished. It is then prudent to pass it over a meadow before it is sent away from the farm. These meadows should always be at the lower part of the farm, and the furthest away from the first delivery of sewage, so that crude sewage does not reach them. If fields are continuously sewaged, the ordinary meadow grass is destroyed, and water grasses only develop which are not nearly so useful as rye grass, and when so used, the plot lessens the power of the farm to deal with the purification of the water and the utilisation of the sewage itself. Osier beds and water meadows should be only adjuncts to a sewage farm unless the area is unlimited.

The possibility of the production of the liver fluke (*Distoma hepaticum*) in sheep, a disease causing great fatality, is used as an objection to sewage farming by Dr. Tidy.

There are times in the year, such as the early spring, when feed is exceedingly plentiful on the farm, and the season dry, when it may be allowable to put a flock of sheep for a week or two upon the fields which have not been recently sewaged, and which it is proposed to break up in the middle of the year; but a manager who habitually feeds sheep upon a sewage farm, is doing that which no sensible farmer would be likely to do, put sheep upon wet meadow land. Those who understood sheep farming only chose dry and open areas for the growth of mutton, with fine short grass, not the free-growing plants which flourish on irrigated meadows. The possibility is no danger to irrigation. If sheep-feeding is adopted, it shows that the manager does not understand his business.

I have said that it is the best plan to take a crop of roots from the land when the rye grass is broken up. The process of breaking up the land is an important one, and must not be delayed beyond the end of the third year. If the crop of grass seems in the third year to be failing, the land should be broken up in the middle of the year, or early in the autumn, and a crop of cabbages (or collards) taken off, leaving the ground ready for mangolds in the following spring. The land must not be sewaged in the same manner as when rye grass was growing upon it. The cabbage and mangold plants will take the sewage very well whilst they are young, and occasionally, as they approach maturity, it will be useful if the weather be dry; but the soil is not to be dressed so frequently as was the case with rye grass, although the arable land, whilst fallow, before the plants have been put in, or whilst they are very young, will bear frequent dressings of sewage, and the soil will fix a considerable amount of fertilising matter in its humus, and hold it, if the weather be cold, until it is wanted. It will be retained until the roots of the growing plants abstract it from the embraces of the soil. I cannot agree with Mr. Bailey Denton as to the superiority of roots over rye grass. Roots should only be used to assist in exhausting the soil of the materials which the rye grass had not taken out.

Cereals are not to be encouraged upon a sewage farm oftener than once in from six to ten years. The sowing must be dependent, to some extent, upon the season. If the mangolds have been clamped early, so that the ground can be prepared for a crop of wheat, that cereal may be sown if season will allow. I have had some of the finest wheat from the Beddington farm that has ever been produced. We had six to seven quarters to the acre; some of it, grown twelve years ago, is on the table, and I think that will speak for itself; but no sewage must be applied after the sowing is completed, for this reason, cereals cripple a narrow area. If the wheat is not sown until the spring, it allows of the use of the fields for frequent dressings in the winter seasons. As a rule, oats are preferable to wheat, as there is abundance of straw, and excellent crops of oats are obtainable which may be used on the farm. The straw works up well as forage for the cattle in the winter time, and it is advantageous on heavy land to dress it with long manure for cereal crops, as the decay of the straw allows of the subsoil being made more porous. I am almost afraid to give a little hearsay evidence as to the growth of rhubarb at Aldershot. I know that we had immense crops from four acres at Beddington, and had no difficulty of disposing of the produce. We did not continue it, not because of the flavour—which had only a "sewage twang" in the imagination of Dr. Tidy's informant — but because it did not utilise the quantity of sewage which the land had to deal with, for it could not be and was not sewaged whilst the crop was being perfected and collected. Rhubarb is somewhat out of place in a sewage farm. I was told that the Aldershot rhubarb, of which there were eleven acres at the Camp farm, made a champagne of the finest brand, at a cost of about 1s. a bottle. I do not advocate market gardening of any kind, though I have seen all kinds of fruit and vegetables grown in the greatest perfection. Strawberries and raspberries, which would have been a credit to any table, and with unsurpassed flavour, whilst the smell of violets, onions, sage, and other plants with strong odours, were so manifest, that anyone walking with his eyes shut could tell the kind of crop by the odours of the crop as he passed along the gardens in which the sewage was actually being used at the time of the visit. Whatever odours the sewage might have caused, they were utterly unable to overcome the natural smell of the spring violets in Mr. Stedman's fields whilst he was taking sewage from the Beddington Farm, and the odour of his strawberries were well known and appreciated in the London markets, where he had no difficulty in disposing of his very satisfactory crop. But market gardening does not answer for sewage farms, because the area cannot take the sewage which has to be utilised, and when the market gardener wanted the sewage most, the sewage farmer could not spare it. The result was a difficulty between the two which led the managers to discontinue the supply to Mr. Stedman's market garden. We also discontinued market gardening for other reasons. The sewage had to be utilised, and the area was too contracted to allow of so much being out of use at the very time when the largest area was required to deal with the Croydon sewage. I give these facts as reasons why sewage farmers should not engage in market gardening unless they have a very extreme area of land to deal with. Voelcker condemned market gardening on sewage farms for these reasons, and not because "sewage clogs the soil."

Let us now pass to the value of the crops

upon farms irrigated with sewage. Dr. Tidy says that sewage produce is best described "as dropsical." He says, "it is difficult to dry, and prone to decompose," and quotes Voelcker as stating that it does not yield so nutritious a product as natural pasture. "If," he says, "you want good produce, you must be content with small quantity." This is an argument which may be as fairly applied to the produce which nature supplies to all regions in which there is a heavy rainfall, to the Valley of the Nile, for instance, as to sewage farms. Dr. Tidy gives a Table containing the per-centage composition of dry substances obtained from plots, one of which was not sewaged, and the other three sewaged from 1,000 tons to 9,000 tons per acre. The same argument has been advanced by other objectors, and I have exposed its fallacy over and over again. The principal deficiency, as shown in Dr. Tidy's Table, is in non-nitrogenous matters; it is very slightly deficient in woody matter, whilst there is an increase in the mineral, fatty, and nitrogenous constituents. Dr. Tidy's error is in taking a sample and analysing that, without reference to the quantity produced from the area treated. Multiply the sample analysed by four times—for that will be about the difference in the weight of the produce—and you will get very different results, the total quantity of sugar produced being very much larger than was the case from his unsewaged meadow. Notwithstanding this sugar, the fattening power of sewage grass is depreciated by Dr. Tidy. If he means that it will not produce the unwieldy and unhealthy cattle that one sees at the Christmas cattle show, I quite agree with him. I do not think that the production of such cattle is to be encouraged; but I do know that bullocks grown upon a sewage farm do give a meat which is free from the loathsome quantity of fat which other food will produce, and which appears to me only to benefit the cook and the rag and bone shop at which she sells the produce of her dripping-pan, to the injury of her master and the increase of his butcher's bill. The meat from sewage-fed cattle is not loaded with fat, but it is solid, substantial meat of good flavour, and does not waste nearly so much in the cook's hands as fat meat usually does. I have repeatedly tried it, and I know that it is very digestible and satisfactory as a diet, and so the guests have found who have fed upon sewage-grown beef, at my own house and at Beddington.

The experiments adduced by Dr. Tidy with milch cows do not exactly correspond with other evidence. He acknowledges that the chemical analysis of the milk from cows fed on sewaged or unsewaged grass does not indicate any material difference. I thank him for this admission, as it renders it unnecessary for me to republish in detail the analyses made by a very eminent chemist, of milk taken from fifteen sewage-fed cows, and which was published in *Bell's Weekly Messenger* five years ago. Those analyses were made of milk taken by the analyst's agent, without notice of his proposed presence at the farm. He came to me without notice, and I took him, with his bottles to Beddington, he saw the cows milked, and he took the milk away with him, not a single person being aware of the possibility of his advent until he appeared. I am justified in re-publishing the average of the whole number, which will show how highly satisfactory the result was to the managers of the farm, and to the produce of cows fed entirely upon Italian rye grass. Wanklyn gives, as his average, for the guidance of analysts:—

Solids, not fat	9·3
Fat	3·2
Water	87·5

The average of those fifteen cows to which I have referred is:—

Specific gravity	1030·05
Per-centage of cream............	15·5
Solids .... { Not fat.. 9·26 / Fat.. .. 4·96 }	14·21
Ash	·64
Chlorine	·065

There was one cow only in the whole list which was comparatively low, the reason for which was not apparent, otherwise the average would have been higher. We were unable to identify the particular cow, so did not discover the reason for the deficiency of cream which certainly existed in the milk from that one cow. The cows milked were the whole of the animals in one of the sheds, and in no way differed from the sixty which at that time were fed upon the farm.

I have to apologise to the members of this Society, and also to Dr. Tidy, for so often referring to his paper, but as that is the *raison d'être* of my presence here to-night, I must continue to follow him. His next description is that of surface irrigation. He does not think that the sanitary aspect of the question is in accord with the agricultural. Again he has misunderstood the whole subject. If there

is not a sanitary success, it is quite impossible for there to be a financial one. They are linked together in one way, though it is possible to be a sanitary success, although not necessarily so financially; but the *vice versâ* cannot arise. Dr. Tidy has taken the evidence afforded by persons who knew nothing of sewage farming, as evidence against the plan; when he asserts that the sewage of two persons applied to an area of land can, in any way, be considered as of any use in settling the question, he shows the weakness of the evidence he adduces. That afforded by the Earl of Essex is much more to the point. I have no doubt that a well laid out field will take and deal with from 5,000 to 10,000 tons of ordinary town sewage per annum, according to its retentive or non-retentive character, provided the quantity of material taken off corresponds with that which had been put on, viz., at least forty tons of produce for each 5,000 tons of fresh town sewage; this will be the sewage of from 100 to 200 persons per acre. Dr. Tidy, however, says that a minimum of 100 equalling an application of about 4,000 tons of sewage is necessary to pay, whilst 30 is the maximum to escape prosecution. I am unable to find a single instance in which such a prosecution has taken place, as will be seen in the report annexed, though immediately before he states, upon the evidence of Professor Robinson, that 19 towns in which irrigation is practised, the average number of persons provided for is 137 per acre. All these nineteen ought to have a prosecution carried out to a successful issue if there is any foundation for Dr. Tidy's opinion, viz., that the sewage of thirty persons to the acre will be the maximum capable of being utilised if the town is to escape prosecution. In the years 1876 and 1877, this Society published a *resumé* of returns from thirty-seven different towns in the kingdom, then utilising their sewage by irrigation; I give the results, as far as I have been able to get them, of the practice still followed in those towns. If Dr. Tidy's statement is correct, we shall have evidence of successful prosecution and arrest of process. I, however, do not find a single case which supports the view he so forcibly expressed in his paper upon this point, and I am at a loss to know upon what grounds he submitted it to this Society.

I cannot pass by intermittent downward filtration without further comment, though I have already stated my own views regarding it. The process is one qualified to provide against river pollution by oxidising the organised material in sewage, and rendering it safe for transmission by river carriage. It is to some extent a necessary adjunct to a sewage farm, which has to deal with immense quantities of sewage, on a small area, or which cannot be easily subdivided, especially if the rainfall is also to be dealt with to any extent. The areas provided by Mr. Bailey Denton, act as filters for the time being, they must be continuously aërated, and the surface frequently broken up so as to allow the filtration to go on. But I prefer an area sufficient for vegetable life to deal with the organised material rather than to turn it into nitrates and nitrates which is the main result of intermittent downward filtration. Every farm should have a portion of its area at the lower part of it capable of being utilised for this purpose, just as every railway must have a break-down gang, should such be required by emergency or accident. It is, however, as an adjunct, not as of first application. For short periods, and at intervals of time, one acre will be enabled to deal with the sewage of 3,000 people on the principles recommended by Mr. Bailey Denton. I agree with Dr. Tidy "in the advantages of intervals of rest alternating with intervals of work," but this is my idea of the work of broad irrigation. In the one case we get the growth of produce which gives wealth for the country, and food for the people, in the other we reduce sewage to its simple elements, and send them away to the sea. The objections which are made against the principle of broad irrigation are such as efficient management, by frequently disturbing the surface of the soil, can always efficiently overcome. Dr. Tidy says, "intermittent downward filtration" had its birthplace in the laboratory; he might have said in the filters of our great water companies. He says also, "no laboratory experiment, pure and simple, can teach sewage treatment." I am again in accord with him, as I am glad to be when I can.

We now come to the hygienic aspect of sewage farming, which is classed under three heads. I dealt with some of these objections so fully, when the subject was discussed by the Society after the reading of Dr. Tidy's paper, that I may refer my hearers to the report which is published in *Journal* No. 1776, that for December 3rd of last year. I will not weary you by reiterating what I then advanced. I must, however, make reference to the action of the Lunacy Commissioners. Some twenty-

three years ago, an attack of dysentery arose in the Cumberland and Westmoreland Asylum, which the resident medical officer thought it possible for the sewage farm to have been the cause. "The facts show," says Dr. Tidy, "that sewage emanations from sewage farms may be the cause of dysentery, diarrhœa, and typhoid fever." I beg leave to differ *in toto* from Dr. Tidy upon this point; the facts showed nothing of the kind, except the notion of *post hoc, ergo propter hoc*. There was not a single point which really proved the sequence as cause and effect. And although sewage utilisation by means of irrigation, sometimes in most insanitary and objectionable ways, as far as the senses are concerned, has been practised in hundreds of places all over the kingdom, no such alliance has ever been proved to exist, and no such result has been satisfactorily brought to the notice of any Court of Law, or to that of the Local Government Board at Whitehall. For this opinion I have the authority of Mr. Arnold Taylor, who supported the statement when I made it before him last year, when he was holding an official inquiry at Croydon, as to an extension of the Norwood farm.

In 1884, the Commissioners in Lunacy issued instructions to the managers of lunatic asylums, "As practical suggestions to those authorities in reference to sewerage, drainage, water supply, and sewage irrigation." There are no other directions as to disposal of sewage except by irrigation, in which the Commissioners, following the advice of a very deservedly distinguished engineer, Sir Robert Rawlinson, have dwelt with the subject on a practical as well as scientific basis. I commend the directions in those instructions to the attention of those interested in the welfare of the country, and would suggest that at any rate the Lunacy Commissioners have no belief in Dr. Tidy's theory that sewage emanating from sewage farms cause dysentery, diarrhœa, and typhoid fever, and they have abundant evidence to rely upon.

Nearly all the lunatic asylums and other establishments for large masses of people which have been built in recent years, such as Sir Richard Cross's asylums for the imbecile, utilise their sewage in the manner indicated by the Lunacy Commissioners; in some cases using the liquid matter in close proximity to their airing grounds without a single proof of mischief from the result. It would be interesting to collect (if time would allow of it) the extracts from the reports of the managers of these institutions to their constituents at Quarter Sessions in different parts of the country, in which it is universally stated that the results are "highly satisfactory." Why Dr. Tidy should ignore this evidence and rest his case upon the shadowy opinions of the *post hoc ergo propter hoc*, passes my comprehension. I have a return before me from Caterham Asylum, which has 2,000 inmates. The report states "that they have no permanent pasture; that 126 acres are cultivated as arable land, or laid down in rye grass as required. The rye grass plots allow of recreation for the patients when such is needed."

Dr. Tidy likens sewage farms to the fens of Lincolnshire and the rice fields of China. The mischief arising in fenny districts is caused by stagnation; it is capable of removal in the larger part; nay, it is removed. The fens are the same districts now as they were before the stagnant water was removed; dysentery is almost unknown there. They have the same contingencies minus stagnation, and they are as healthy, if they are drained, as any other parts of the kingdom. If there is stagnation upon a sewage farm there is no financial result, and then there might be such conditions as is described, but such a state is no part of sewage farm cultivation. Dr. Tidy sums up his denunciations of sewage farming, on page 1150 of our *Journal*, in a series of charges, most of which counteract each other. As, for instance, that "an untrained observer," such are his words, can easily form a conclusion "that conditions vary;" surely every agriculturist knows that, and knows also that he must prepare his land accordingly. "Inequality of purification," "uncertainty of action," must be met by alteration of arrangement. If there is heavy rain, you must increase your area under sewage for the time being, or arrange to exclude the rainfall. It must be passed over a double set of plots, one after the other. The first being rye grass, or possibly arable, the second may be meadow. None of the conditions described by Dr. Tidy are parts of good sewage farming; his ague, his dysentery, and his diarrhœa, exist only in his active brain, for there is not a particle of reliable evidence to connect them even with sewage farm mismanagement, let alone the correct way of dealing with the matter.

The remark as to the pollution of the subsoil water, which is possible, is also as pertinent as that which might be applied to railway management. If they do not exercise proper care, life will be lost; but the law requires

proper care, and the loss of life is almost *nil.*

Let me now refer to the remarks upon the distribution of the ova of the entozoa by sewage farms. I mentioned my correspondence with Dr. Cobbold on the occasion when I addressed the Society in the discussion upon Dr. Tidy's paper. The occasion arose in this way. I wrote to him, inviting him to a breakfast upon the farm upon sewage-grown produce, in 1875. A family bereavement at that time prevented Dr. Cobbold's acceptance of my invitation. In his reply, he says, "I have been obliged to put a check, and to modify my views, upon the subject of sewage, which I formerly displayed, on purely scientific grounds."

Some time after that, a herd of beasts which had been fed for two years upon sewage produce on the sewage farm were in process of slaughtering by a carcass butcher, and I invited Dr. Cobbold to witness the process, and inspect for himself the bodies of the animals as they were killed, as well as those which had been cut up for two days. He was not well, and excused himself from making the inspection, stating at the same time that he had modified his opinions, and become quite convinced that the views he had held, as to the possible propagation of tapeworm eggs, and the distribution of hydatids, or of the cysticerci, were not likely to arise in beasts fed on sewage produce. I have never seen hydatids in animals fed at Beddington. I believe they are not found at Birmingham. Thousands of animals have been fed upon these two farms, and used as food, and it would have been impossible for the existence of such a result to have escaped the observation of the lynx-eyed observers who are always at hand to decry the results of sewage farming. I do not deny the possibilty of such a result, but I think it highly improbable, because the conditions under which the ova of human parasites continue to be propagated, do not hold in the method under which sewage ought to be distributed. If Dr. Tidy could produce an animal infected as he suggests, it would not be an argument against sewage farming, but it would be grounds for serious charges against the managers of the farm upon which it took place, in allowing cattle to go upon recently sewaged areas. It is impossible to suppose that the ova of creatures which only propagate themselves in the human juices, and at a temperature of 98·5, could retain their vitality in the sewage, and upon the soil for a fortnight under the circumstances of a deprivation of moisture and exposure to light and air that must happen to them if distributed by broad irrigation. I believe the ova presented to the radicles of rye grass are as efficiently digested by that plant as the little fly is by the *Dionea muscipula*, or the ova of the dead frog by the amœba in the wayside ditch, or the particle of meat which may be caught by the tentacles of the sea anemone in a seaside pool.

Dr. Tidy says, that as regards the disease produced by the *Trichina spiralis* "no doubt the danger is constant, but sewage irrigation would render it an affair of certainty." However Dr. Tidy could pen such a baseless statement passes my comprehension, for the produce of more than 100 irrigated areas are utilised as food at this moment. I have never met with a case connected in any way with sewage farming, and I ask Dr. Tidy to produce the series which ought to be forthcoming in support of such a statement.

Dr. Tidy's conclusions that to achieve commercial success you must abandon sanitary considerations, are shown by my proofs to be utterly untenable. I contend that financial or commercial success can only follow when sanitary considerations are strictly attended to. Financial loss goes with non-attention both to letter and spirit of sanitary law.

Let sanitary law be looked after, let the local authority do its duty in dismissing sewage as rapidly as possible from within the borders of the town, so that all such may be on the farm within six hours. Let the authority keep out from the sewers the rainfall, except such as falls upon paved streets, courts and alleys. Let them provide the land which is required for the purpose, and not only will the sanitary result be highly satisfactory, but the financial result will be satisfactory too. I do not mean to assert that a sewage farm can meet the engineering charges which may be necessary to get the sewage upon the land; I do not mean to assert that a sewage farm can pay a rent sufficient to cover interest and principal when so-called building ground has to be taken for the purpose. Such charges must be borne by the locality providing the sewage. There is, however, this certainty about it, that the dearer the land which is taken, the greater and the denser will be the population for which it has to be provided. The higher the rateable value of the district, the more able will it be to bear the consequent charges, which in no case, if common honesty and common sense be used, ever need be more than a quarterly rate of 1d. in the

£, or 2d. per half-year. This is about the rate which towns may have to pay to have their sewage utilised, and themselves freed from its evil consequences, if it be retained in their midst. In addition to this charge, they must also pay the requisite engineering charges for the production of sewers, which shall not be sewers of deposit, or deliver stinking sewage at their outfall. The denser the population, and the higher the value of land, the greater will be the demand for milk, cabbages, and meat in that locality, and the more certain the market, therefore, for the produce raised on the farm. Whilst as to the fund sunk in the production of the works, it will not be lost, but will be a fund which will be the evidence of wealth among the people who advance the money, of a much more satisfactory character than is the wealth which the French people possess in consequence of the occupation of Paris by the Prussians in the last war, and no place would be more enriched by such a proceeding than the great metropolis itself.

It may be pertinently asked, if the conclusions I have arrived at are so satisfactory, why does not sewage farming become more general. Let me give you the experience of the Borough of Blackburn. The corporation of the borough triumphed over immense engineering difficulties, and obtained the land required for the purpose. They could not agree with the owner, they took it, therefore, by arbitration, though it was only agricultural land in its strict sense, 380 acres of land, bringing in at most £580 a year. They were compelled to pay seventy-nine years' purchase for that land, whilst the cost of the arbitration amounted to the enormous sum of £13,500. This result was enough to frighten any corporation from attempting to obtain land for such purposes again, and since that time very few attempts have been made to do so. A greater legal robbery was never perpetrated, or a more obvious case of people being made to pay through the nose for what they had a perfect right to take at a fair agricultural value. Sewage farming is very heavily handicapped; it is opposed by many of the chemists who find it to their interests to support the chemical side of the question; it is opposed by all interested in companies for the sale of patent manures, and of those interested in the speculations which belongs to shares; it is opposed by all who are likely to get promotion money for other schemes, or to be called as witnesses by parties interested in raising the value of the land proposed to be taken. It has no supporters except those who follow sanitary work for the sanitary work's sake. The Blackburn Corporation are, however, deserving of the greatest praise; they have 510 acres of land, for some of which the arbitrator made them pay far beyond the amount claimed even by the owner. In some of it there is a difference of 200 feet in the level. Their engineering and financial difficulties were immense, but taking their two farms together, there is a gain of £300 a-year. With such a result before a corporation or a local board, and the difficulty which the Upper Thames Valley authorities found in their efforts to get land, it is not surprising that they hesitate to commit themselves to sewage farming, but continue to flounder about in chemical works and precipitation schemes. The law as to the powers of a local authority to take possession of land for public purposes requires to be seriously altered before it is likely that such schemes will be promoted by corporations, unless by agreement as to price with the land owner.

As I have mentioned, in the year 1876 and 1877, the Society of Arts organised a series of meetings to discuss the sewage question. At both those meetings reports were presented as to the custom followed in all the large towns of the kingdom. In thirty-eight cases the sewage had been or was about to be dealt with by means of irrigation. I have written to the authorities in all those towns, asking them to give me a few lines upon the present state of the case; whether irrigation is still practised, and with what success, and if not, why not? Appended are the answers I have received from thirty-four of those towns, and I return my thanks to the town clerks and engineers who so kindly responded to my application.

In 30 out 38 the answer is a decisively satisfactory one; in six there is no reply, though I know personally that in four the process is satisfactorily continued. No injunctions have been suggested except in one case (Kidderminster) in which damages are claimed. In one small place (Hoole) the sewage now goes into the Chester sewers, and in another (Oswestry) irrigation has been discontinued, because the site was inapplicable for the purpose. There is no hesitation as to the result sanitarily, though nearly all deplore the fall of agricultural prices, and fail to obtain the financial result which they had anticipated. The reasons for this are manifest either in the nature of the works, the surcharge with expenses they ought not to bear, or the gigantic

faults made in the original conception of the scheme. But the broad fact is still patent that sewage can produce a certain result if it be dealt with properly, and no town is justified in allowing that 5s. per head to be recklessly destroyed, when, by reason of Continental contingencies, it might make all the difference between famine and surrender to our national enemies, or to a triumphant result in a terrible contest.

Report upon present practice as to Sewage Utilisation in those towns in which Sewage Irrigation was practised in the year 1877, *as then reported to the Society of Arts; in alphabetical order.*

Aberdeen, 1876.—44 acres of land irrigated for the past six years with good results.—Mr. Goodall, the Town Clerk, now reports that the system is still in operation; it is only for the third part of the city, and only during a portion of the year, just as in 1876. He is informed that the effluent water is comparatively pure.

Abingdon, 1876.—The works are combined with intermittent downward filtration.—(No return.)

Altrincham, 1876.—Direct irrigation in operation five years.—(No return.)

Banbury, 1876.—Sewage pumped to farm of 138 acres.—Mr. T. Pain, clerk to the Local Board, writes:—"Irrigation is still followed, the system is found to be very satisfactory; there is no complaint, either with regard to the character of the effluent, or of any nuisance arising from smell."

Bedford, 1876.—Sewage pumped to 180 acres of land.—Mr. J. H. Collet writes:—"The system is still carried on with great success as far as the sewage is concerned, but by reason of excessive rents, and the low price of produce, it is not paying at the present time; we see very little of the effluent, having very few acres of the land underdrained. Our sewage is passed through the soil, which is of a very porous character."

Blackburn, 1876.—Irrigation practised for three years.—Mr. Squire, the Town Clerk, writes that the Corporation have about 400 acres under irrigation, and that the process is commercially successful. The facts mentioned in the text of my paper are taken from an excellent *resumé* of the works prepared by Mr. J. B. McCallum, the Borough engineer, which shows what skill can effect.

Birmingham, 1876. — 12,000,000 gallons daily treated with lime at Saltley, and the sewage then utilised upon land by irrigation.—Mr. W. S. Till, engineer to the Board, states, in a recently published paper, that the necessity for lime treatment arises from the nature of the manufactures of Birmingham. That they have 1,227 acres available for sewage disposal. That 16,000,000 gallons are daily utilised on the farm. The Corporation realised £4,406 last year by the sale of milk. The income for the sale of stock and plant was £22,728; whilst the payments which included rates, taxes, and purchase of stock (£7,760), amounted to £22,822. I visited this farm last year, and was conducted over it by Alderman Avory. The condition of the stock was everything that could be desired as to health and nutrition; there was an entire absence of any of those conditions suggested by Dr. Tidy. The manner in which it is worked as a milk-producing farm is highly creditable to the managers. But there are cultivations which do not belong to a sewage farm. It is worthy of imitation, as showing what may be done in stock-keeping and milk-producing. Only 100 acres are laid down with rye grass. There can be no doubt as to the satisfactory character of the effluent, and also the absence of nuisance from the farm itself, though the quantity of sludge is something enormous.

Bodmin, in 1876, utilised their sewage by direct irrigation of grass land.—No return has been received.

Cheltenham, 1876. — Irrigation on grass land carried on for about ten years.—Mr. Bridge, the Town Clerk, writes:—"Since the date of last report to the Society of Arts, we have purchased 230 acres of land three miles out of the town. The effluent is fairly clear, and we have no complaints. At one of the farms it is passed through some filter beds before being passed into the stream. We let the farms, and we sell dressings of the fluid sewage to the farms on the line of the outfall sewers. The income is about £1,000 a year. We have not completed one of the farms, but when the whole is let we expect to increase the rental. The outlay, including management, interest, and repayment of loan, amounts to about £2,200 a year. A penny in the £ produces £900, consequently the net cost of the disposal of our sewage is about 1¼d. in the £ on the rateable value, this, it being understood, includes interest on the purchase-money of the farms, which cost us £22,000, and the annual repayment of principal."

Chelmsford, 1876.—Pumped up for irrigation for ten years past.—No return as to present use.

Chorley, 1876.—500,000 gallons per day utilised on sewage farm, but report says pail system found (?) best in this locality in respect of cleanliness and utilisation.—Mr. Jackson, the Town Clerk, now writes:—"We have still a sewage farm for the utilisation of sewage, which is upon the whole, from a sanitary point of view, quite satisfactory, but the subsoil of the land is clay, and the effluent not so pure as it would otherwise be. Pecuniarily the farm is not a success, the loss annually being about £200 or £300 a year. This is attributable, perhaps, here rather to local causes than to the faults of the system."

Crewe, 1876.—Only small parts utilised by irrigation, principally dirty water from London and North Western railway works.—(No return.)

Croydon, 1876.— Irrigation for the past sixteen years. Net cost in 1875 equal to 1½d. in the £ rate, including rental of 360 acres of land at £10 an acre. —Now (1887) the Corporation have more than 700

acres of land which are used for irrigation. It has been purchased at an average cost of more than £300 an acre, and since the purchase a great expenditure has been incurred in building cottages for workmen, and erecting proper farm buildings, so that the old system of starving the farm need not be continued. It had been the custom to avoid the purchase of stock; to pay into current account the sums received for the sale of that which was on the farm, so as to reduce current rate, but not to provide for the consumption of produce next year. The result was, as I have stated in my paper, the destruction of more than 200 acres of rye grass land, whilst new fields were not prepared. In 1877 and 1878, the receipts from produce were £7,162 and £7,585 respectively, but in 1880 it sank to £4,088 and in 1881 to £3,891, entirely from mismanagement by irresponsible farm committees, who declined to continue the plan of producing milk and using up produce by their own stock. The receipts from sale of milk dropped from £2,320 to £819. At this juncture a wise and far-sighted milk farmer erected cowhouses for 300 cows upon a part of the farm at Beddington, and entered into an agreement with the Corporation for the supply of grass, and raised the income to the Corporation, for the sale of grass, to the figure it had occupied in 1879, viz., £2,300. The proprietor of those cowsheds has, at this moment, one of the finest herds of cattle to be found in any part of the country, producing an abundance of rich milk which has a very ready sale, and his cattle will (like those at Birmingham) be able to hold their own for weight, personal appearance, sleekness, with any herd in the kingdom, for they are carefully groomed and kept, as cattle ought to be, as clean as a stud of horses. He is doing what the Croydon Corporation were unable to do, to the great advantage of the neighbourhood, and I have not the least doubt also to his own pecuniary benefit. I wish him most perfect success. The income from the farm, during the year ending Lady-day, 1886, amounted to £9,181; the expenditure to £5,101. I am unable to say how the valuation of the live and dead stock upon the farm stands, as it is not included in the published accounts, but I have reason to believe that it is increased and not diminished. I would, however, remark that it is utterly impossible to farm a large property, like that which is in the hands of the Corporation, unless there is stock upon the land to utilise the produce, and 700 acres ought to have a valuation of at least £14,000, to do justice to the work which has to be done. The larger the stock with which the managers have to work, the better the chance of a good pecuniary result. This is seen in the fact that, whereas the farm ought and could, with proper management, now produce £15,000 a-year, there has been only obtained £9,000. The working expenses have, however, been all met, and £4,000 forthcoming towards the payment of interest and principal upon the purchase money; and somewhat less than a 2d. rate enables the locality to deal with its sewage without fouling the rivers of the district. As regards its sanitary effect upon the locality, in 1881 I read a paper before the International Medical Congress in London, based upon the experiences of the Croydon sewage farm. The nine propositions which I then submitted, and which are embodied in their "Transactions," have never been controverted. I will now add the vital statistics of the parish of Beddington and the hamlet of Wallington, in which the farm is situated, and which takes up about one-seventh of its area.

Year.	Population.	Rateable Value.
1861	1,557	£11,700
1871	2,874	20,671
1881	5,492	42,456
1886	6,000	46,520

The birth-rate has been gradually rising, and the death-rate gradually falling, during the whole of the time. From the above figures it will be seen that the proximity of a large sewage farm has not prevented the steady increase in a given neighbourhood. There has been steady increase in population, and rise in rateable value of the parish, from 1,557 persons and £11,700 rateable value when the farm was first started, to over 6,000 persons and a value of £46,520 in 1886. Where, then, is Dr. Tidy's idea of depreciated value, increased unhealthiness, and prevalence of diarrhœa, dysentery, and typhoid fever. Surely land upon which sewage has been utilised by irrigation for more than thirty years, would show the effects, if it was injurious, upon the 6,000 well-to-do persons who have come within a mile of its borders since it has been established, the area of the farm taking np one-seventh of the whole parish. As regards the analyses of effluent water which have been occasionally made, they have, as far as I know, always been sufficiently pure to go into the Thames, without the least chance of evil to the fish of the Wandle or the human beings on its borders. I am not advocating the theory that effluent is proper water to drink. I have always urged that it is not intended for that purpose, but it is safe where the affluent from certain precipitation processes is not. It contains excess of chlorine, and when applied too long to one plot there will be an escape of some of the nitrogen. It is a fault of management, and not a fault of the system. Dr. Tidy does not deny the capacity of soil and vegetation to purify sewage; that which can be done by one or the other can always be done by both if a proper supervision is exercised.

Doncaster, 1877.—Sewage pumped upon farm three miles away.—Mr. Shirley, the Town Clerk, writes:—"The borough possesses 263 acres, laid out, in 1873, by Mr. B. S. Brundell. It was leased in 1874 to the brother of the engineer, at an annual rent of £812. The lease expiring this 2nd of February, the Corporation advertised for tenders, and finally let the farm at an annual rate of £550, with 15 acres of additional pasture, the then tenant only offering £500. The farm is about two miles from Doncaster, and we have

never heard of the smallest complaint. We have a population of about 25,000 people."

Epsom, 1877.—About three-fourths of sewage dealt with by subsidence and irrigation upon 60 acres of land rented by the Board.

Windsor and Eton, 1876.—Sewage dealt with by irrigation on separate system. Has been in operation for six years on 50 acres.—Mr. Whitehouse, the Surveyor, writes:—"We have carried on the irrigation system with great success since 1870 to the present day. The town and college are drained upon the separate system, to the total exclusion of storm and surface water. There is no complaint from any one living near to the farm. The farm was laid out by the late Mr. Menzies."

Harrogate, 1876.—Irrigation in use seven years for portion of locality.—Mr. W. H. Wyles writes:—"We have a sewage farm of 310 acres, over which the sewage has flowed for a good many years, in some parts for nearly twenty. There is no pumping. The natural slopes offer easy gradients. The effluent passes into the brook sufficiently pure to satisfy keen and hostile observers. Our only practical difficulty arises from the nature of the soil. This is, then, with a clay subsoil which quickly hardens in winter, and cracks in summer, so that we have to exercise the greatest care. Still the results to us are, on the whole, satisfactory."

Hoole, 1876.—Irrigation for seven years past; population 1,720.—Mr. Weaver, the clerk to Local Board, writes that complaints were made against the filtering tanks which the Local Board used before allowing the sewage to go on to the land in 1882, and since that time their sewage has gone into the Chester outfall sewer, and the practice discontinued.

Kendal, 1876.—Downward filtration and irrigation for portion of the sewage.—Mr. Bolton, the Town Clerk, writes:—"Mr. Alderman Nilhson gives me notes. Downward intermittent filtration is carried on here with the same success which has attended it during the past ten years. We have about 9 acres of under-drained land, cropped in the following manner:—2½ acres rye grass, and 6½ acres producing a great variety of vegetables of good quality in about 5 ft. ridges; carrots last year, over 14 tons to the acre. Some of the beds were afflicted with grub two years ago; we found that a dressing of gas lime was a preventive. We have 4 acres of grass land, over which we flow the sewage about four times a year. The remainder, about 8½ acres, is brought into a high state of cultivation by applying the sediment of the filtering tanks, and lets at £5 per acre. The acres can be worked by two men and one horse, and the produce leaves a profit, after payment of the costs of working, of £60 a year. The effluent water of the outlet is always clear. The drawback is having too much subsoil water, amounting to 1,000,000 gals. a day, to deal with."

Kidderminster, 1876.—Sewage dealt with by irrigation.—Mr. Jas. Morton, the Town Clerk, writes:—"Irrigation still carried on upon the Corporation farm in the same manner as in 1876. The effluent is perfectly clear and without smell, as I can personally testify. Mr. Arthur Coomber, the borough engineer, says that the effluent is perfectly clear, and in every way satisfactory. The farm is at the present time in a highly satisfactory condition. Mr. Morton, however, informs me that a neighbouring owner is claiming damages for depreciation, which will have to be settled by an appeal to a law court."

Leamington, 1876.—Sewage used upon a farm belonging to the Earl of Warwick.—The Town Clerk now writes that irrigation is still carried out upon Lord Warwick's farm. During the last sixteen years I have never heard a complaint arising from the effluent water. The corporation have just made a fresh arrangement with Lord Warwick for continuing the agreement, by which he receives the sewage for a further period of thirty years.

Leek, 1876.—Portion dealt with by irrigation. It has been found the best method of disposing of water-carried sewage; 450,000 gallons every twenty-four hours.—Mr. K. Farrow writes:—"In 1860 a covenant was entered into with certain land owners to use the sewage by irrigation. All went well for many years, but some extensive silk dye works and print works were established, which added about 200,000 gallons of waste water to the sewage, that became so diluted as to be of little value for irrigation, and consequently the whole found its way into the river. The dyers have now constructed a separate sewer for the waste dye water, and the sewage is restored to its usual state. We shall now be able to go on satisfactorily again. No payment is made by the land owners for the sewage."

Longton, 1876.—Sewage used by irrigation upon land belonging to the Duke of Sutherland. The Duke to pay £500 a year for it.—Mr. Hawley, the Town Clerk, writes:—"I have no means of knowing what result the character of the effluent has been attained, but I have never heard of any complaint. The same contract exists as in 1876."

Merthyr Tydvil, 1876.—Intermittent downward filtration on 20 acres, and wide irrigation on 200 acres.—(No return.)

Malvern, 1876.—Intended to adopt the intermittent downward filtration scheme and irrigation proper, used for irrigation in 1877.—Mr. Jno. Palmer, the Town Surveyor, writes:—"The system has been in operation since 1882, viz., broad irrigation and intermittent downward filtration. It is working satisfactorily, with a good effluent. The total area under cultivation is about 35 acres, 11 acres of which is under the intermittent filtration, and is divided into 11 sections, 2½ acres of osiers, and the remainder broad irrigation. We have a farmstead; nearly the whole of the produce is consumed by the stock. There is a ready sale for the osiers, and all the crops during the past year have been excellent. We have separated the storm water from the sewage, except that from the tops of houses and yards. If laid

out with our present experience, we could materially improve the construction, and get a much higher standard of purity."

Northampton, 1876.—Just completed farm, at cost of £75,000, for utilisation of sewage by irrigation.—Mr. Shoesmith, the Town Clerk, writes:—"We have had no complaint as to the character of the effluent for many years. The result is satisfactory, although a very small sum per annum is realised in the shape of rent or interest upon outlay."

Norwich, 1876.—Sewage pumped to land 150 feet above, and 24 miles from the station. Irrigation has been in use for four years. 3,000,000 gallons every 24 hours.—Mr. Marshall, the city engineer, states that the farm has been successful in purifying the sewage, but as a commercial speculation it has not been so; the sewage is poor, but few water-closets in the city, and the sewage almost all spring rain-water. The farm is let out to a good tenant, who works it as a dairy farm. We lose about £100 a-year on the rent. I think it does fairly well.

Ormskirk, 1877.—Sewage, utilised by irrigation, has been in action nine years.—(No return.)

Oxford, 1877.—Sewage will be utilised by irrigation, being pumped to a farm of 320 acres; is being laid out.—Mr. W. H. White, the engineer to the Oxford Local Board, writes:—"Sewage was pumped to the land first in 1880. We get a satisfactory effluent, and there are no complaints of the farm from adjoining occupiers. Roughly, the financial result of our operations is that the produce of the farm rather more than pays the actual working expenses."

Reading, 1876.—Sewage farm, 490 acres, in process of formation.—(No return.)

Reigate, 1876.—Sewage utilised on farm.—Dr. Grace, the Town Clerk, writes:—"Utilisation of sewage by irrigation has been carried on in this borough for the past 18 years. To say that no complaint as to the character of the effluent water would be to say rather too much; but the complaints ceased when the council removed some agricultural drains into which the sewage matter penetrated, and escaped without being duly purified, and the complaints have not since been audible."

Stoke-upon-Trent, 1876.—Sewage irrigation proposed but not carried out.—Mr. W. Bagnall, the Town Clerk, writes:—"The sewage is now dealt with by means of irrigation and downward precipitation on a small farm of 61 acres. The effluent is very satisfactory, the farm is let at a low rental of £120 a year."

Tunbridge Wells, 1876.—Sewage utilised by irrigation.—Mr. Lewes, clerk to Local Board, writes:—"The sewage is still utilised by irrigation. The authority have two farms, one north and the other south of the town, samples of the effluent are taken fortnightly at each farm, which, up to the present time, have been satisfactory. The results have also proved very satisfactory."

Tyldesley, 1876.—Portion of sewage dealt with by irrigation, only six w.c.'s.—Mr. Amos Cranshaw, clerk to Board, writes:—"The same system is still practised in this district as in 1876, but in a different locality, with a satisfactory result as to character of effluent. The Local Board have now purchased a farm of 131 acres at a cost of £13,400. The whole of the farm is not yet laid out, but sufficient is so for the satisfactory treatment of the sewage of 7,000 inhabitants. The sewage has been flowing on this land for two and a-half years. The farm is let to a tenant at £200 a-year."

Warwick, 1876.—Sewage dealt with by irrigation pumped upon 135 acres of stiff clay. Mr. Greenway, the Town Clerk, writes:—"The Town Council have not altered their system of sewage utilisation by irrigation, which was adopted many years ago. They believe it to be the best mode of dealing with this difficult subject. I must, at the same time, admit that the effluent is not at all so satisfactory as could be wished, but an increased filtering area, which has been recently constructed, will remove all difficulty in this direction. Financially, I cannot speak so hopefully; the result has been a heavy loss to the town."

West Derby, 1877.—Sewage dealt with by irrigation, 723,000 gallons in twenty-four hours.—Messrs. Layton and Steel, clerks to Local Board, write:—"The time system is carried on at the farm. So far as we are aware, the result as to character of the effluent is satisfactory."

Winchester, 1877.—A scheme is being promoted for pumping sewage to farm by lift of 100 feet, to be then treated by irrigation. Mr. Walter Bailey, the town clerk, writes:—"The sewage of this city is utilised by means of irrigation with complete success. The land consists of forty acres, a mile from the city. The sewage is conveyed by gravitation to the pumping station, from whence it is raised by steam-pamp to the land, 150 feet at the highest point. No nuisance is occasioned. There is no effluent water to be dealt with. The system has been in operation about eight years, and gives great satisfaction. Apart from the pumping expenses, the farm is carried on at a profit, excluding the purchase of the land."

Wolverhampton, 1877.—Sewage dealt with by irrigation upon farm of 300 acres, purchased for £32,000. Mr. Berrington, the borough engineer, writes:—We have a farm of 300 acres, but the peculiar character of the sewage, being irony, coupled with the storm water, has ruined it. If we had plenty of land, irrigation would turn out a satisfactory effluent. Notwithstanding that, we have a very small trout stream into which we have to pour our effluent. My opinion is that while we have a sewage containing sometimes 62 grains of iron per gallon. we shall never turnout a safe effluent, for iron must get on to the land, and ruin it, or into the effluent, and spoil it."

Wrexham, 1877.—Here is a sewage farm of eighty acres in lease to Corporation, underlet to Colonel Jones. House water complained of by tenant.

Colonel Jones now writes:—"There are no complaints as to the effluent from the farm, which is carefully watched by the Corporation of Chester, from a natural anxiety about their water supply, derived from the River Dee, below the confluence with the brook, which receives all the drainage water from this farm. Of course, the fall in prices of agricultural produce has materially affected our finances. I still pay in rent, rates, and taxes nearly £5 per acre. I still keep accurate accounts, such as were published for the first seven years up to the date of my receiving the £100 prize in 1879, and keep my head above water. You will find a full report of everything in the *Journal of the Royal Agricultaral Society*, Part 1, No. 31, 1880, and in pamphlet published 1885, by Potter, Wrexham, 'Will a Sewage Farm Pay.'"

DISCUSSION.

Sir Robert Rawlinson, C.B., on being called upon by the President, said he was engaged in getting together information as to dealing with sewage, both by precipitation and irrigation, and his mouth was therefore almost sealed, but he must say he had listened to the paper with the greatest interest and pleasure. Dr. Carpenter had clearly stated the case, without exaggeration, and although he had repeatedly referred to Dr. Tidy, he could not recognise one remark which that gentleman could take as offensive. He had been engaged on this question more or less for the last thirty years, not as a chemist, but as an engineer, and had inspected nearly every sewage farm in the country, not executed within the last ten years, and many abroad; and only a week ago he received from Paris two volumes on the subject; one on the extension of sewage irrigation about to take place there, and the other with regard to sewage irrigation at Berlin. He knew from other sources that the Continentals as well as the Americans and Australians were watching very closely what was being done in England, in order to obtain the most recent information for their own instruction. Very near home there was the most gigantic experiment going on, not, however, in providing for irrigation, but, on the contrary, how to expend money in precipitating suspended matters from the crude sewage, which did not purify it, and then to turn this polluting fluid into the river, as at present. The Metropolitan Board of Works, by its Act of Parliament as originally granted, was intended to provide the means to prevent the Thames being polluted, but how they had carried out that obligation everyone knew, for the Thames had been continuously polluted from that time up to this day. The process now being undertaken to disinfect the sewage was in his opinion extravagant to the utmost degree. He had worked out the figures roughly, which led him to the conclusion that taking the costs of land, tanks, engines, pumps, chemicals, steam-barges, and labour in manipulation, and the volume of sewage to be dealt with, it would represent a capital equivalent to £10,000,000 sterling. If other methods were taken to deal with the pollution of the Thames, there would of course be available a sum of £10,000,000 to carry out a process of irrigation. The Chairman, and those associated with him, in an early report on the subject, contemplated providing carriers to take that sewage down to the estuary; other persons also took a similar view of the question, and proposed the reclamation of the barren sands on the foreshore. He would unhesitating say that if the sewage of the metropolis could be dealt with in that manner, instead of being retained where it was to undergo so-called chemical treatment, and could be converged by conduits to the margin of the sea, and arrangements made for irrigating the lands on both sides of the conduit, in a few years, during nine months out of twelve, there would be a claim on the managers for the whole of it to be distributed in its crude state over the surface of the land. He did not contemplate tying up the outflow of sewage without leaving a door open to get rid of a portion when it might not be wanted, in very wet seasons, but that there should be a means of discharging the surplus, but that was a matter of detail. With proper treatment, such as had been indicated, and with such a vast population amongst whom the produce of the ground could be made available within a comparatively short period, three-fourths of the entire crude sewage of London might be utilised for agricultural purposes with the advantages and saving indicated by Dr. Carpenter. He did not contemplate a net profit after paying expenses, but there would be no such cost as, capitalised, would amount to one-tenth of the interest upon £10,000,000. Reference had been made to a case where sewage irrigation was somewhat blown upon at that unfortunate asylum in Cumberland. He went down there on behalf of the Lunacy Commissioners, to inspect, and he found putrid sewage pumped from a putrid tank on to a small piece of land for several days continuously, and with no sort of attention, until the whole area was covered with stagnant sewage. To that ground the patients had access, some of them probably being what were known as dirty patients, to whom nothing was too repulsive to handle. He called the governor's attention to it, and told him it was a wonder that the whole place had not taken fever. It was about the foulest abuse he had ever seen.

Dr. Charles Drysdale said he had been delighted to hear the opinion of Sir Robert Rawlinson; for it seemed to him that Dr. Carpenter's case was entirely won when he had such a response from that distinguished engineer. He had always considered Dr. Carpenter the best authority on this question, because, fortunately for him, he had nothing

to gain from it as an engineer or a chemist; he spoke merely as a man of science who had lived by the side of one of the best-managed sewage farms in the country. It was the height of insanity for the Board of Works to have sanctioned a plan which would have no effect whatever on the sewage, and would only put the ratepayers to an enormous expense. When he was in Paris in 1878, he visited the sewage farm there, and found it admirable in every respect, the effluent which fell into the Seine being so pure that all the visitors drank of it. The greater portion of the farms were market gardens, and the magnificent produce of every kind struck the whole of the attendants at the International Hygienic Congress. With respect to Berlin, he had in his hand an account sent him by Mr. Aird, the engineer, giving an account of the success of the sewage farm there. Fortunately, in this case there was an autocratic Government, which could do what it liked; here most of the people in any particular neighbourhood knew nothing of the subject, and yet you had to get their consent. Mr. Aird said the purchase of the land cost £55,000, drainage and laying out £29,000, and the sewage farms in work yielded a surplus the first year of £1,800. So satisfied were the people of Berlin, that, as Mr. Aird again informed him in a more recent letter, the authorities proposed to buy 2,000 acres of land, and the idea was accepted without any discussion. Yet here in London, the metropolis of the world, containing men of the greatest eminence, the experience of the whole of the Continent was to go for nought, and ten millions were to be spent for no good whatever. The tank itself was to cost a million, and a hideous mass of sludge was to be carried down and plastered on the banks of the river. The difficulty could be easily met, as Sir Robert Rawlinson had said; and he thought very likely if the sewage were taken down in a long conduit in the direction of the Maplin Sands, and branches given off in all directions, a large portion of Essex might be irrigated. As a member of a scientific profession, he indignantly protested against the way in which the Board of Works were carrying out this matter.

Mr. SILLAR thought Dr. Carpenter and Dr. Tidy did not occupy quite the same ground, for while Dr. Tidy treated the utilisation of land for the treatment of sewage, Dr. Carpenter dealt with the utilisation of sewage for the treatment of land; and the two things, although apparently alike, were really very different. Every one knew that liquid manure had a good agricultural effect, but when using it you must not put it on in excess or at improper times. Where you had a certain limited area of land, and were obliged to use on it the whole sewage of a place—where there was no safety-valve or outlet—it was the utilisation of land for the treatment of sewage, and you were likely to get disastrous results; but if you had liberty to take what sewage you wished, and when you liked, and let the rest run away when you did not want it, it was simply applying liquid manure to a field, and it would be very strange indeed if, with good management, you could not get good results. The Craigentinney meadows were an excellent illustration of this. The sewage flowed past these meadows and ran into the sea, and the owner or occupier tapped the conduit and took what he required. He got very excellent crops of rye grass, but when he (Mr. Sillar) visited the place, he saw a large quantity of wheat, which rather surprised him, and he asked the farmer how it was. He said he did not put sewage on that land, it was manured in the ordinary way. Then he asked him why, as he had the land under sewage, he did not put it all under rye grass, and he said he only grew that to the extent for which he could find a market for it. There was, in fact, a limit to the sale of rye grass, and if this plan were to be pursued in the metropolis, no one could say how it could be all got rid of. The only objection he had to raise to Dr. Carpenter's plan was, that there was a still better one. It was not right to condemn all precipitation processes, for by them you could obtain all the valuable constituents of the sewage in a form which could be carried to any distance, and be applied to any description of crops. Thus you would be carrying out, even better than Dr. Carpenter suggested, his idea of providing food for the people.

Major LAMOROCK FLOWER said Dr. Carpenter had drawn rather a rosy picture of sewage irrigation, but he feared he had not allowed sufficiently for the fallibility of human nature. He (Major Flower) saw a large number of sewage farms in the course of his daily duty, and, unfortunately, he found the irrigation was not always properly carried out. It was more frequently neglected than properly attended to. If he could find the conditions which Dr. Carpenter had so fully and clearly laid down, he should strongly support irrigation above every other method of dealing with sewage.

Dr. DRYSDALE said he should be much obliged if Dr. Carpenter could give the meeting an idea of how to apply the irrigation method to so large a body of fluid as the sewage of London.

The CHAIRMAN, in proposing a vote of thanks to Dr. Carpenter, said he had been very much pleased with the excellent paper. Dr. Carpenter had certainly dealt with the subject in a very complete manner, and the points to which he had called attention were those which deserved very careful consideration on the part of all interested in the disposal of sewage, and the prevention of the pollution of rivers, and especially those interested in the London sewage question. It was pefectly true that it was a great waste to send into the sea such a vast amount of fertilising matter as was discharged from the sewers every year; and although, as Dr. Carpenter put it, they would have to pay something for getting rid of

it, yet that valuable matter should not be turned out of the country uselessly. He was very glad to find a strong expression of opinion on the question of the metropolitan sewage, both from Sir Robert Rawlinson and others, and trusted that the discussion would produce in time a very useful effect in assisting in proper arrangements being made by the Metropolitan Board of Works for dealing with this most important subject.

The vote of thanks having been carried unanimously,

Dr. Carpenter, in reply, said he should have liked to have heard something from Mr. Baldwin Latham, who had done more to promote sewage irrigation than probably anyone else. As would be seen in the appendix to the paper, many of the irrigation works had been laid out under his direction, and in all these cases the reply to his inquiries was most satisfactory. He quite agreed with Major Flower as to the fallibility of human nature, especially in the case of local boards and corporations. Unfortunately the education of the people in this subject was not proceeding so rapidly as he hoped some time ago would be the case. There was an idea that the taking of land for sewage irrigation involved an enormous expense. He wanted to show that such was not the case where it had been carried out with ordinary common-sense, and those towns had found almost without exception that the sewage question for the time being had been solved, except where there had been that vacillation of purpose which belonged unfortunately to farm committees, going first in one direction and then in another. He did not see the great difference which Mr. Sillar had referred to between utilising land for sewage, and utilising sewage for land, but with regard to the Craigentinney meadows, and only dealing with produce which could be sold, that was one of the great difficulties of sewage farming. Until it had been shown that land could be farmed at a profit, it was not likely that farmers would, especially under present circumstances, be ready to embark capital in what appeared to be a speculation. It was a very important point for town councils and local boards to bring their farms into such a state of efficiency, by good management and proper stocking, that they could show that it did pay, but many bodies did not stock their farms properly. The result was that they had to pay a very high price for their land and had no stock upon it, which was like a shopkeeper taking a shop in a leading thoroughfare, and paying a high rent, and then not stocking his shop. The result was the farm was not utilised to the extent it might be. The Craigentinney farmer was a case in point. Whatever he did he could not produce as much milk as Edinburgh could consume; and the same was the case here. All the sewage of London would not produce enough milk for the people of London, who wanted an abundant supply of pure milk more than anything else. Without that you could not have a healthy population; you could not get that power of constitution in young children which they ought to have, if they had not an ample supply of pure milk. To his mind it was one of the duties of a municipality to provide the food the people wanted. If the ten millions were utilised in the way he suggested, and another eight or ten millions were added to it, and placed in the hands of Mr. Latham, with Sir Robert Rawlinson at his right hand, there was no doubt the whole sewage of London could be utilised in this way, and an abundant supply of material provided for the purposes of the community without any loss, but with the certainty of absolutely enriching the country to that extent. He had not a word to say against the ABC process, which, under certain circumstances, might come in useful, but with regard to the production of both kinds of food, animal as well as vegetable, that was exactly what he always said ought to be aimed at. The rye grass must be consumed; if you waited until people came to take it away the farm would not prosper. Close to the Croydon farm there was a private individual who had a magnificent herd of cattle fed on the produce of the sewage farm, as fine cattle as could be seen anywhere. In Birmingham also there were a splendid herd of cows fed on the farm, and a large amount of milk was produced, as would be seen in the appendix. It was the duty of a Corporation to utilise the food they grew (not to wait until someone came for it), with a proper amount of stock, and then they would have produce which would be of use to the country, and show a good financial result.

Obituary.

Sir J. U. Bateman-Champain, K.C.M.G.—Colonel Sir J. U. Bateman-Champain, Director-in-Chief of the Indo-European Government Telegraph Department, died at San Remo on Tuesday, 1st inst. His first commission dated from June 11, 1853. He served in the Mutiny campaign throughout the Delhi siege and preliminary operations, from the actions on the Hindun river and at Badlikeserai to the storming, and was wounded during the siege. In 1862, when the late Lieutenant-Colonel Patrick Stewart, C.B., R.E., was sent to Persia to arrange for the construction of the Indo-European telegraph, Lieutenant Champain was specially selected to accompany him, and the next year he returned to Persia to carry out the Persian portion of the line. On the death of Colonel Stewart at Constantinople, in the beginning of 1865, Champain was associated with Major-General Sir Frederick Goldsmid in the chief direction of the whole system between England and India, and on Sir F. Goldsmid's retirement, in

1869, Champain became sole director-in-chief. In May, 1878, Major Bateman-Champain read a paper on "Telegraph Routes between England and India," before the Indian Section of the Society of Arts, and he frequently took part in the discussions at the meetings of the Society.

SIR JOSEPH WHITWORTH, BART., D.C.L., LL.D., F.R.S.—Sir Joseph Whitworth died on Saturday night, 22nd January, at the English Hotel, Mount Carlo, in his 84th year. He was born at Stockport on the 21st December, 1803, and after receiving a small amount of school education and passing a certain time at several workshops, he came to London and entered Maudslay's. Here he completed the true plane, and subsequently he went to Holtzapffel's and to Clements's; at the latter workshop he was employed upon Babbage's calculating machine. In 1833, he commenced business on his own account at Manchester as a manufacturer of engineers' tools, and at the Exhibition of 1851 he showed his true plane, and the measuring machine indicating to the millionth of an inch. In 1853, Mr. Whitworth went to America as one of the Royal Commissioners to the New York Exhibition, and in that capacity he drew up a special report on American manufacturing industry; and on his return home he began to study the principles of construction underlying the manufacture of rifles and rifled artillery. The War-office erected, at its own expense, a shooting gallery of 500 yards long, in Mr. Whitworth's grounds at Rusholme, Manchester, in order that he might make the requisite experiments under favourable conditions and without interruption. In 1857, Mr. Whitworth was elected a Fellow of the Royal Society, and as far back as 1844 he became a member of the Society of Arts. In 1868, he was awarded the Albert Gold Medal "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a degree of perfection hitherto unapproached, to the great advancement of arts, manufactures, and commerce." He was a Vice-President of the Society in the year 1868-69, and in 1873 he offered prizes to the value of £100 to be awarded by the Society of Arts for the best essays on the "Advantages that would be likely to arise if railway companies and limited companies generally were each to establish a savings' bank for the working classes in their employ." In response to this offer fifty-three essays were sent in, but the judges reported that no essay was of sufficient merit to be entitled to the full prize. £50 was, however, awarded to Mr. Joseph Mason for his essay. Mr. Whitworth was created a Baronet in 1869, and subsequently the University of Oxford conferred upon him the honorary degree of D.C.L. Mr. Whitworth instituted in 1869 the Whitworth Scholarships, consisting of thirty scholarships of £100 a year each, to be held for two or three years, for the encouragement of mechanical and engineering science.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 9.—"Purity of Beer." By A. GORDON SALAMON. J. H. PULESTON, M.P., will preside.

FEBRUARY 16.—"Uses, Objects, and Methods of Technical Education in Elementary Schools." By HENRY H. CUNYNGHAME.

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART.

MARCH 2.—"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

MARCH 9.—"Railway Brakes." By WILLIAM P. MARSHALL. Sir FREDERICK BRAMWELL, F.R.S., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

FEBRUARY 11.—"The Economical Condition of India." By DR. WATT, C.I.E. Sir GEORGE BIRDWOOD, M.D., LL.D., C.S.I., will preside.

FEBRUARY 25.—"New Markets and Extension of Railways in India and Burmah." By HOLT S. HALLETT, F.R.G.S.

MARCH 4.—"Our Trade Routes to the East." By MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B.

MARCH 25.—"Indian Coffee." By FREDERICK CLIFFORD.

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

MAY 27.—"Indian Tea." By Dr. T. BERRY WHITE. H. S. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 15.—"Colonial Woods." By ALLAN RANSOME.

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 22.—"Wrought Ironwork." By J. STARKIE GARDNER, F.G.S.

MARCH 15.—"The Application of Gems to the Art of the Goldsmith." By ALFRED PHILLIPS.

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

Cantor Lectures.

The Second Course will be on the "Diseases of Plants, with special reference to Agriculture and Forestry." By T. L. W. Thudichum, M.D. Three Lectures.

Lecture III.—February 7.—Animal parasites as causes of epidemic plant diseases, illustrated by the Phylloxera. — Comparison with Oïdium.—Aphides or green-fly.—Survey of parasites on forest trees.—Necessity of greater attention to forest culture as a science.—Physical and chemical causes and effects of diseases of plants.—Comparison with vegetable ferments, beneficial and hurtful.—Diseases of wine and beer.—Conclusion.

The Third Course will be on "Building Materials." By W. Y. Dent, F.C.S., F.I.C. Four Lectures.

February 14, 21, 28; March 7.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. J. L. W. Thudichum, "The Diseases of Plants, with special regard to Agriculture and Forestry." (Lecture III.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Inaugural Address by the President, Prof. Henry Robinson.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. W. Jago, "Fermentation in its relation to Bread-making." 2. Mr. J. Mactear, "A new Method of Elevating Liquids, especially Acids." And other papers.

Inventors' Institute, Lonsdale-chambers, Chancery-lane, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Lord Grimthorpe, "Nature."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. B. Richmond, "Art in the Past."

Tuesday, Feb. 8...Camera Club (at the House of the Society of Arts), 11 a.m. Photographic Conference. Reading of papers aud discussion.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture IV.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on Mr. William Joseph Dibdin's paper, "Sewage-Sludge and its Disposal," and on Mr. William Santo Crimp's paper, "Filter-Presses for the Treatment of Sewage-Sludge."

Photographic, 5A, Pall-mall East, S.W., 8 p.m. Annual Meeting.

Anthropological, 3, Hanover-square, W., 8½ p.m. Lieut.-Col. Sir Charles Wilson, "Notes on the Tribes of the Nile Valley North of Khartum."

Colonial Institute, Prince's-hall, Piccadilly, W., 8 p.m. Mr. D. Morris, "Fruit as a Factor in Colonial Commerce."

Wednesday, Feb. 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. Gordon Salamon, "Purity of Beer."

Geological, Burlington-house, W., 8 p.m. 1. Mr. T. W. Edgeworth David, "Evidence of Glacial Action in the Carboniferous and Hawkesbury Series, New South Wales." 2. Captain F. W. Hutton, "The Eruption of Mount Tarawera." 3. Mr. Josiah Martin, "The Terraces of Rotomahana, New Zealand."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. Presidential Address by Rev. Dr. Dallinger, "Recent Optical Improvements in the Microscope, and the Operation of the Darwinian Law amongst the minutest organisms."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. Mr. W. Spence, "The Construction of Specifications and Trial of Patent Cases."

Shelley, University College, Gower-street, W.C., 8 p.m. Dr. J. Todhunter, "*The Triumph of Life.*"

Thursday, Feb. 10...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. S. Thompson, "Electric Bells." (Lecture I.)

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. W. Rücker, "Molecular Forces." (Lecture IV.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on Prof. Silvanus P. Thompson's paper, "Telephonic Investigations."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, Feb. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Dr. George Watt, "The Economical Condition of India."

United Service Institute, Whitehall-yard, 3 p.m. Admiral Sir George Elliot, "Coast Defence by Gunboats."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. E. B. Poulton, "Gilded Chrysalides."

Astronomical, Burlington-house, W., 8 p.m. Annual Meeting.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Miss Grace Latham, "Volumnia."

Saturday, Feb. 12...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "Modern Composers of Classical Song—Rubenstein, Raff, and Greig" (with Vocal Illustrations). (Lecture IV.)

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Annual General Meeting. 2. Mr. E. Gibson and Mr. R. A. Gregory, "Note on the Tenacity of Spun Glass."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Correction.—One passage of Mr. Debenham's remarks in the discussion on Mr. Traill Taylor's paper was incorrectly reported (see p. 200, *Journal*, January 28, second column). The paragraph commencing on line sixteen should read as follows:—"Perhaps the most ideally perfect photograph would be one taken with a lens in which no provision was made for overcoming curvature of field, so that spherical aberration might be more completely grappled with, but a curved plate would have to be used to receive this image."

Journal of the Society of Arts.

No. 1,786. Vol. XXXV.

FRIDAY, FEBRUARY 11, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list of subscriptions promised by members of the Society of Arts to the Fund for the Imperial Institute:—

	£	s.	d.
Charles Denton Abel	20	0	0
Sir Frederick Abel, C.B., D.C.L., F.R.S., Vice-President	50	0	0
William Anderson, Member of Council	50	0	0
Sir William Andrew, C.I.E.	20	0	0
The Attorney-General, M.P., Member of Council	30	0	0
Henry McLauchlan Backler, F.R.G.S.	10	10	0
W. J. S. Barber-Starkey	5	0	0
Edward Beanes	5	0	0
Sir Francis Dillon Bell, K.C.M.G., C.B., Member of Council	30	0	0
George Blagden	2	0	0
John Bloomer	5	5	0
Francis Botting	0	10	6
Edward M. Browell	5	5	0
S. M. Burroughs (Messrs. Burroughs, Welcome & Co.)	5	0	0
Alfred Carpmael, Vice-President	20	0	0
Charles Cheston, M.A., Member of Council	20	0	0
B. Francis Cobb, Treasurer	10	0	0
Henry L. Cohen	5	0	0
Sir Daniel Cooper, Bart., K.C.M.G.	100	0	0
T. R. Crampton, Vice-President	30	0	0
Sir Juland Danvers, K.C.S.I., Member of Council	10	0	0
Professor James Dewar, M.A., F.R.S., Vice-President	10	0	0
F. W. Docker	5	5	0
Henry Doulton, Member of Council	100	0	0
D. J. Russell Duncan	5	0	0
W. Dashwood Fane	5	0	0
Robert Galbraith, jun.	2	0	0
Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of Council	50	0	0
Carried forward	610	15	6

	£	s.	d.
Brought forward	610	15	6
Colonel William Gray	10	10	0
Andrew Greig, C.E.	1	1	0
George Godwin, F.R.S.	30	0	0
Colonel R. Harrison, C.B., C.M.G.	2	2	0
William Henry Haynes	0	10	6
E. R. Holland	3	3	0
J. Satchell Hopkins	10	0	0
J. Bennett Howell	5	0	0
Professor D. E. Hughes, F.R.S.	5	0	0
Charles W. Jackson	1	1	0
Col. Robert Raynsford Jackson	10	0	0
Henry Joachim	2	2	0
J. Henry Johnson	5	0	0
Rev. W. Taylor Jones	1	1	0
E. T. Kensington	3	3	0
Henry Kent	5	0	0
Edwin Lawrence, LL.B., B.A.	100	0	0
Alfred Le Grand	1	1	0
James Leverson	2	2	0
Mrs. McGarel	5	0	0
George Matthey, F.R.S., Vice-President	30	0	0
Messrs. Meyer and Mortimer	105	0	0
E. Chambers Nicholson	100	0	0
Colonel Chas. H. Page, J.P.	1	1	0
Mrs. Paine	2	0	0
James Paxman (Messrs. Davey, Paxman, and Co.)	100	0	0
W. H. Preece, F.R.S., Vice-President	10	0	0
Sir Robert Rawlinson, C.B., Vice-President	20	0	0
Henry D. Rhodes	1	1	0
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E. C. Robins	5	0	0
Rev. Henry Ross, M.A.	1	1	0
Sir Arthur Rugge-Price, Bart.	20	0	0
"W. R. S."	5	0	0
Sir Saul Samuel, K.C.M.G., C.B., Member of Council	30	0	0
James Solly	2	2	0
John Thompson	10	0	0
Alfred Savill Tomkins	1	1	0
Rev. J. P. Tomlinson	5	0	0
Philip F. Walker	10	10	0
William Westgarth	100	0	0
J. H. Whadcoat, F.S.S., F.C.A.	2	2	0
W. C. Wheatley	1	1	0
R. R. Whitehead, M.A., J.P.	5	0	0
Thomas W. Wing	50	0	0
James T. Wood, M.A.	10	0	0
Henry Edward Wright	10	10	0
John Yeats, LL.D.	5	0	0
Total	1,489	2	0

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

CANTOR LECTURES.

The third and concluding lecture of the course on "The Diseases of Plants, with special reference to Agriculture and Forestry," was delivered by Dr. THUDICHUM, on Monday evening, 7th inst. At the conclusion of the lecture a vote of thanks was passed to the lecturer on the motion of the CHAIRMAN.

The lectures will be printed in the *Journal* during the summer recess.

Proceedings of the Society.

NINTH ORDINARY MEETING.

Wednesday, February 9th, 1887; J. H. PULESTON, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Hall, Carl, Grosvenor-house, Swansea.
Jacks, Thomas William Moseley, 72, Stafford-street, Wednesbury.
McMorran, Alexander, Galloway-house, Carlton-road, Putney, S.W.
Mockford, Henry, 13, Manson-place, Queen's-gate, S.W.
Ryland, William, Rye-lodge, Nether-edge, Sheffield.
Stocken, Alfred William, 5A, Halkin-street, Belgrave-square, S.W.

The following candidates were balloted for and duly elected members of the Society.

Binyon, Brightwen, 5, Henley-road, Ipswich.
Boake, Arthur, Southwood-lawn, Highgate, N.
Cormack, M. T., M.A., Shepherd's-lane, Brixton, S.W.
Dallmeyer, Thomas R., 19, Bloomsbury-street, W.C.
Sinauer, Sigismund, 9, Kensington-palace-gardens, W.
Stephenson, Joseph Gurdon Leycester, 6, Drapers'-gardens, E.C.
Vernon, Rev. E. H. Harcourt, 104, Cromwell-road, S.W.

The paper read was—

THE PURITY OF BEER.

BY A. GORDON SALAMON, A.R.S.M., F.C.S.

Some words of preliminary explanation are necessary in order to justify my appearance here this evening. A feeling has long existed hat our national beverage, as retailed throughout the country, and more especially to the working man, is no longer pure and invigorating. An impression is prevalent that adulteration is practised to a large and pernicious extent, and that such adulteration is possible because of the increased latitude in the choice of materials conferred upon brewers by the declaration of the "free mash tun," in accordance with the provisions of the Inland Revenue Act of 1880.

Public opinion, which is seldom altogether at fault, has indeed expressed itself so strongly in the matter as to have encouraged, and in a great measure justified, the drafting of numerous Acts of Parliament designed with a view to render adulteration impossible. The projected measures are admittedly subversive of existing legislation, and are intended to modify the effects of the Revenue Act referred to, better known as that which involved the repeal of the malt tax. It is only necessary to compare the provisions of that Act with those that preceded it, in order to see how completely it revolutionised not only the fiscal laws regulating the levying and collection of duty upon beer, but also the conditions under which the process of brewing may be practised in this country.

The repeal of the malt tax was not alone conceived in the interest of fiscal legislature. It involved considerations affecting the farmer, and, above all, it took cognisance of the discoveries of chemists, and allowed of their utilisation by the brewer. It was a measure which accorded with the spirit of the time, inasmuch as it stimulated and encouraged industrial research, and provided a fresh outlet for the products of inventive ingenuity. Apart from the main question as to whether it has or has not opened the door to adulteration, it will not be denied that it has been attended with results more startling than could have been anticipated by those statesmen who were concerned with the drafting of the bill. It has dealt a grievous blow at monopoly. It has had the result of impressing upon brewers the necessity of making themselves acquainted with the science of their art. It has given rise to new and important industries, which have brought wealth to masters, and profitable labour to men. It has afforded facilities for brewers with small establishments and slender means to produce, independently of locality, beer of a class demanded by their customers, for the supply of which many were previously dependent upon those breweries more favourably situated with respect to water supply and

other equally important conditions. Previous to the repeal of the malt tax, Burton held the virtual monopoly of pale ale production, and Dublin that of stout. To-day almost every brewer is enabled, if he choose, to brew his own bitter and his own stout. The result may not have been disastrous to Burton or to Dublin—as recently published balance-sheets will attest—but it has certainly not been encouraging to either. London brewers used formerly to limit their production to mild ale, stout, and porter, and relied exclusively upon Burton as one of the few pale ale centres for the supply of their bitter. To-day some of the largest firms are producing this class of beer, comparable in quality to much if not most of that sent from the Midlands. Indeed, they have in some instances erected new breweries devoted exclusively to the production of this article. Dinner beer consumed in private houses was formerly heavy and heady. It is now produced in a form which is at once sparkling, light, palatable, and, within ordinary limits, non-intoxicating. A demand has arisen for a less alcoholic beer than that brewed under the conditions of the old Act. This demand has been met to a very considerable extent, and in a manner which would have been impossible but for the declaration of the "free mash tun." Indeed, had the existing demand prevailed together with the old restrictions upon brewing, it is difficult to see what barrier could have been opposed to an enormous import into this country of Continental beer, to the manifest exclusion of our own. Truly, our exports have considerably diminished; but the new Act has at any rate permitted of our facing the competition from Germany, and evidence of this is furnished by the very large exports made by firms in Somersetshire, Kent, and elsewhere. Moreover, it will not be denied, by those really acquainted with the subject, that the standard of English beer, as produced in the brewery—mark, not as retailed in the public-house—has improved, and not deteriorated. The ordinary mild ale, as now manufactured in small breweries all over the country, has undergone a manifest change for the better. This statement will be scoffed at by some until they have made deeper inquiries into the question, then they will convince themselves of its accuracy. Beers low in gravity and alcoholic power can now be produced that will keep as long as the strongest and most heavily hopped; formerly this was impossible. It is more than probable that the possibility of producing a light, palatable, and non-intoxicating beer has had much to with creating the demand. If this be so, then it is clear that the repeal of the malt tax has tended in the direction of Continental temperance, as distinguished from total abstinence; for it has afforded facilities for the brewing of beer which can be consumed without ill effects to the brain or the digestive functions. The demand for such a beverage is steadily increasing, and will, in time, extend to the public-house trade. Brewers have hitherto been encouraged to meet it, and have done so with marked success.

It will be admitted that, if this has been the tendency of the repeal of the malt tax, its repeal has effected much, so much, indeed, as to preclude the possibility of the free mash tun being interfered with, unless good cause can be shown for the necessity of such action.

It is stated that such a necessity actually exists. It is averred by those whose honesty of motive is not to be called in question, that it has resulted in the production of adulterated beer, and has reacted prejudicially to the farmer. These are weighty accusations, and if they can be substantiated, there can be no doubt that those concerned in the agitation of this question are fully justified in the course they are pursuing.

But the considerations involved in these questions are also weighty, and they are, above all, technical. They involve not only a knowledge of the conditions under which beer is made and sold, but also a detailed acquaintance with the chemistry of the subject, which is particularly difficult and abstruse. An opinion formed upon the superficial merits of the case would lead to erroneous conclusions, and probably to unjust legislation. Opportunity has allowed of my investigating this question somewhat deeply; and it is in the hope that I may be able to offer proof of this assertion, and that I may stimulate and contribute to a fair discussion of the question, before it comes before the consideration of Parliament, that I respectfully invite your earnest attention to my remarks.

It is contended that the proposed legislation will effectually prevent the adulteration of beer, and will afford a measure of relief to the British farmer. I submit, with respect, that these views are erroneous, and are entirely misconceived. In my humble opinion, it will encourage adulteration rather than suppress it, and will handicap the farmer rather than help him.

The title of the measure by which it is sought to remedy these evils is "A Bill for better securing the Purity of Beer." It was introduced before the last Parliament by Mr. Quilter, who advanced it sufficiently far to secure its second reading. The dissolution of Parliament put an end to its further progress; but its promoters feel justified, on the strength of the partial success gained last year, and by the accession of new and influential adherents, in resubmitting it this session to the consideration of Parliament. It should be stated that last year it was allowed to pass a second reading on sufferance only, and that Sir William Harcourt, then Chancellor of the Exchequer, stated his intention, on behalf of the Government, of carefully considering the Bill when it reached committee stage. It would seem, however, that the contemplated alterations had reference to fiscal matters rather than to an interference with the scope and object of the Bill. It encountered no opposition of moment, it stimulated the feeblest of discussions, and, in view of the great interests involved, it can only be inferred that its more technical aspects had not been adequately brought before the notice of members.

The provisions of the projected measure enact that "every person who sells, or exposes for sale, by wholesale or retail, any beer brewed from or containing any ingredients other than hops or malt from barley, shall keep conspicuously posted at the bar, or other place where such beer is exposed for sale, and on every cask or other vessel in which the same is sold, a legible notice stating what other ingredients are contained in such beer."

A whole group of measures, almost identical in terms, and certainly indentical in scope, were drafted during the last session. For the purposes of this paper it will, however, suffice to refer to the one from which I have quoted, and which is known as Mr. Quilter's Bill.

A preliminary objection of much importance must be taken to the wording of the Bill, which is opposed to actual and ascertained fact. No beer as brewed contains a trace of malt from barley. It contains the complicated series of products resulting from the chemical changes which barley-malt undergoes in the process of brewing, and those products have been stated by no less an authority than Watts, in his "Dictionary of Chemistry" (first supplement, p. 256), to be impossible of analytical distinction from those resulting from the use of malt adjuncts other than barley, used in the preparation of beer. There are, indeed, certain characteristics typical of an all-malt beer. They are most objectionable characteristics, and will be fully discussed in the course of this paper; but so far as the alcohol producing constituents and the true beer constituents are concerned, it is impossible to distinguish between an all-malt beer and a beer brewed with a due per-centage of malt adjuncts.

I have here two sealed bottles, both containing beer practically of the same gravity. They have been prepared with the same barley-malt, and with an equal quantity of the same sample of hops. The one is an all-malt beer, the other has been prepared with the substitution of twenty per cent. of malt adjuncts for barley-malt. I shall be happy to submit them to any gentleman who may wish to have them examined by a competent chemist, with a view to discovering which is which. I will predict that there is only one possibility of effecting the discovery, and that is by the isolation from the all-malt beer of ingredients which I shall be able to prove are detrimental to its keeping properties, are typical of low-class English barleys, and are the source of constant anxiety to the brewer. These objectionable ingredients are absent in malt adjuncts, and I shall show how the latter are instrumental in obscuring their injurious influences, and of rendering them inert. I have labelled the two bottles B and C, and I have placed in a sealed envelope a paper stating which is the all-malt, and which is the malt adjunct beer. I propose that this envelope shall be opened by any gentleman agreed upon, after the receipt of the chemist's report, and that the latter shall be further requested to report as to which is the more wholesome sample.

Now, if it can be proved, in this and other ways, that the ultimate product is the same whether barley-malt alone or barley-malt plus malt adjuncts be employed, it would seem manifestly unfair to handicap the latter, or to propose legislation which might have that effect. Apart from agricultural considerations, it is the public who have to be consulted; and if they are willing to drink a malt adjunct beer, and it is abundantly clear that they are, and if it be proved to be harmless it is difficult to see the justice of attempting to prevent them from so doing. Surely what concerns the public is what comes out of the mash tun in the process of brewing, and not what goes into it. It were as reasonable to enact that no salicylic acid made from coal tar should be sold for the requirements of

human beings, unless a notice to that effect were affixed to every packet sold.

The promoters of the Bill would seem to be divided in their views as to the necessity for its adoption by the House of Commons. Mr. Quilter bases his argument upon the fact that beer, as now consumed, is adulterated, and that the Bill would render such adulteration impossible. In an article upon the subject, published in the January number of the *Nineteenth Century*, he says:—"At the outset I must disclaim the slightest desire to protect the British farmer, or any one else, at the expense of the consumer; it is impossible to legislate without inflicting direct injury on some, whilst producing direct benefit to the many." The motives by which Mr. Quilter is actuated are stated with equal frankness. "The beer which is consumed," he says (*loc. cit.*), "may be divided into three categories:—first that which is made from barley-malt, hops, and water; secondly, that which is made of innocuous substitutes; thirdly, that which is made of noxious substitutes, and which is fitly described in the eastern counties by the somewhat vigorous word 'muck.' . . . . We have a clear case against the third category. We think we have a good case against the second; we therefore do not propose to exterminate the second; but we hope to enable the consumer to distinguish between the first and second."

The Right Hon. Henry Chaplin, who has given his support to the proposed Bill, does so, however, for a totally different reason. He distinctly states that he is desirous of causing the abandonment of the use of substitutes. At a meeting of the council of the Central and Associated Chambers of Commerce, held in this hall, on the 8th December last, he said:—

"The motion which is now before us appears to me to be one of the many indications of the extreme agricultural depression, from which the agricultural interest is suffering at the present time. The situation, generally speaking, at the present time, especially in the eastern and southern counties of the kingdom—the corn-growing districts of the country—is, in my humble opinion, deplorable in the extreme. I doubt, indeed, whether there has ever been a period when it has been quite so bad, and for that reason everyone connected with the agricultural interest is casting about in search of remedies. The remedies are very hard to find, and when they are found they may be harder still to carry out; but it has always appeared to me that some amendment of the law in connection with this particular question—the pure beer question—which is now before us, would be probably attended with less difficulty than a remedy in any other direction. We hope," he says later on in his speech, "that it may have the double effect which has been pointed out by Baron Dimsdale, and that in the first place it will give to the public a more wholesome and a purer beer, and that it will, in the second place, improve the position of the growers of barley and of hops. . . . . I confess that, if the effect of such legislation would be to cause the abandonment of those substitutes, that is the very object which we have in view, and which we desire to accomplish. . . . . If the result of legislation of this kind was to introduce so large a consumption of foreign barley as to be still further injurious to the growers of barley in this country, I cannot conceive why on earth some reduction of the existing beer duty should not be made, and the deficiency raised by a duty upon foreign barley instead."

In the first instance, I propose to direct your attention to the arguments of Mr. Quilter.

It is necessary that there should be no misconception as to one effect which Mr. Quilter's Bill would produce. There would scarcely be a barrel of beer sold which would not have to be characterised by some qualifying notice. It is very well to speak in theoretical terms of a beer brewed entirely from malt and hops, and containing no other ingredients; but does such a beer really exist in practice? My experience is that, if it be so, it is the rare exception, and not the rule. It is certainly not the case with Burton beer, and Burton may be regarded as the home and centre of barley-malt beer. Experience has proved that, with the majority of barley malts, it is impossible to brew a beer which will keep in good condition unless preservatives or malt adjuncts be employed. In Burton it has been the general custom to dispense with malt adjuncts, and to use either bisulphite of lime, or some other form of acid sulphite. Indeed, to such an extent has it been found necessary to employ these antiseptics, that in many of the pale ale establishments it has been usual to add them in every stage of the brewing operation. It has been found necessary to use them, because there exists in the generality of barley malt beers small quantities of specific nutrifying ingredients which constitute a favourable culture medium for what are known to the brewer as false ferments. These are organisms which, as the result of their life and multiplications, give rise to excretive products which introduce into the beer a feverish briskness, and odours which should not be found in sound and wholesome malt liquor. They induce what the brewer knows as

"frets" and "stinks," and if they manifest themselves to any appreciable extent, they render the beer comparatively unsaleable. I do not go so far to state that when malt adjuncts are employed, the use of antiseptics is rendered unnecessary; but it is a matter of common knowledge that the quantity which need then be added is reduced to a minimum. Neither do I assert that these antiseptics are harmful to the human system; on the contrary, I know that the quantity employed is perfectly innocuous; but it requires a somewhat intimate acquaintance with the subject before this conclusion can be arrived at, and it would be quite out of the question to expect an average working man to possess the information. Nevertheless, in the terms of Mr. Quilter's Bill, it would be necessary to affix a notice to almost every cask of barley-malt beer retailed, stating that it was prepared from barley malt, hops, and bisulphite of lime. Certainly it would be the case with nearly all Burton beer, and I cannot but think it would prejudice consumers against an article that has long justly held so favoured a position. It could not be contended that bisulphite of lime would be excepted from the Bill because it assisted in the production of a barley-malt beer. It is foreign to beer making as sought to be practised under Mr. Quilter's Bill, and it is largely and almost universally employed. If it were banished from the brewhouse together with malt adjuncts, then it may fairly be contended that very little English barley could be employed in the production of sound English keeping beer. Hence we are forced to the conclusion that, what Mr. Quilter terms "the first category" has, so far as his own definition is concerned, practically no existence in fact; nay, more, we must admit that nearly all beer as retailed would have to be described by a qualifying notice.

It is somewhat peculiar that Mr. Quilter should so frequently have called attention to the beer retailed throughout the Eastern Counties as typical of what he believes to be an adulterated article, and as he states, fitly described by the somewhat vigorous term "muck." It is to be presumed that Mr. Quilter's remarks apply to the entire locality, and not to any particular district. Had this not been the case, he would undoubtedly have stated and denounced the district where such "muck" was sold. Now I say it is peculiar that he should have located the Eastern Counties as the seat of the "muck" production, for it is well known that several of the largest and most influential brewers in the Eastern Counties pride themselves upon being producers of all-malt beers. They use no malt adjuncts; either because they cannot overcome the prejudice with which they regard any departure from the lines upon which they have been taught to brew, or because they see no great economy in so doing. Moreover, the public houses *exclusively* served by these brewers ramify and extend throughout the whole of the Eastern Counties, so that we are justified in concluding that a proportion, at any rate, of the "muck" that is sold is barley-malt beer, and is not prepared with noxious malt or hop substitutes. And yet if we were to taste the beer at any of the breweries in question, it would be admitted that, for brilliancy and flavour, they left but little to be desired. This brings me to the heart of the question. Is beer, as retailed by the publican, the same in quality and condition as when it leaves the brewery? Is it tampered with by the retailer? If so, what is the nature of the tampering? To what extent does it prevail?

If water or sugar and water be added to beer, unless it be done with the greatest skill and care, it will nullify all the efforts of the brewer, and will convert his product into what is commonly known as "swipes." If the publican fines his own beer in the public house cellar, then the odds are in favour of his being able to add water, or sugar and water, without entirely disfiguring the sample; but if the beer is delivered to him fined and shived down, or containing finings and shived down, as is often the case with country breweries, then it is impossible to adulterate without disastrously affecting the appearance and the taste of the beer. If, notwithstanding this knowledge, sugar and water be added, and the treatment be tolerated, it cannot be wondered at that "muck" is sold in lieu of genuine beer.

Now there is no good in blinking facts, and however unpleasant the statement may be, there is no doubt that many publicans do tamper with their beer. It is manifestly to their interest to convert five barrels as sold to them by the brewers into six or more barrels as retailed by them over the counter. Unfortunately it has been only too well proved that this practice of dilution has prevailed to a very great extent among publicans; and I rejoice to think that the practice has at length been exposed. It has not been proved that they add ingredients which are deleterious to health; on the contrary, it has been abundantly shown that the adulteration consists in the addition

of sugar and water to the beer, and, in some very rare cases, of salt. If the addition of sugar and water be skilfully made, under certain conditions of fining, no harm results to the beer, but in many instances it entirely defeats the efforts of the brewer to produce a really high-class beer. In this it is extremely hard upon the brewer, because that which he has taken an infinity of trouble to make brilliant, sound, and generally acceptable, is by adulteration often converted into an article that is by comparison unfit for consumption. It is clearly not in the interest of the brewery proprietor that such an addition of sugar and water is made, for it is manifest that, in the absence of such a practice, he would sell genuine beer in place of the sugar and water added. Neither is such a proceeding legal. The law distinctly protects the public against any such tampering, for it is enacted (Inland Revenue Act, 1885, Sec. 8) that the publican is not permitted to add anything to the beer delivered to him by the brewer, "except finings for the purposes of clarification." It has been abundantly proved that this law has been set at defiance, and the practice has at length been brought home against the offenders. In my humble opinion, the law should long since have been set in motion. However, the attention of the Excise having been directed to the matter, prompt and vigorous steps have been taken to protect the public. Numerous prosecutions have resulted, and I am informed that a systematic organisation has been perfected in order to detect and deal with such practices in future. Whether such practices are general throughout the country, I am unable to state. My opinion is that, when attention is directed to the matter, it will be found that they are.

Now I have no hesitation in stating it as my opinion that the complaints which Mr. Quilter and others have to some extent justly preferred against English beer, as sold to the working man, are in the main attributable to this vicious system of dilution. Mr. Quilter is of opinion that adulteration is practised inside the brewery. I do not share his views. I believe, on the contrary, that it is practised outside the brewery. Mr. Quilter (*Nineteenth Century, loc. cit.*), invites anyone who doubts the fact of adulteration being practised, to send for a pint of "fourpenny" from the nearest public house, and he predicts that he will not send for a second. But let Mr. Quilter taste a glass of that same fourpenny as produced in the brewery, and as sold to the publican, and I venture to predict that he will not at all object to drink a second.

I should be sorry to make a general charge against publicans. I regret having to make one at all; but we have lately had abundant proof that many of them are in the habit of tampering with their beer, and it is this very proof that, to my mind, constitutes so weak a point in Mr. Quilter's arguments. In order to put a stop to this objectionable practice on the part of some publicans, we do not want new laws; we require nothing but a due enforcement of those that exist. We cannot, however, deny that recent proceedings have shown that publicans can, if they are so disposed, run the gauntlet of Excise prosecutions, and dilute their beer. Notwithstanding the present vigilance of the Excise, there can be no doubt that they can try to run that gauntlet as well to-day as they did six months ago. The prospects of success may not be so great, but still they can do it, and the chances are in favour of some of them making the attempt. Mr. Quilter's Bill does not recognise the possibility of such an attempt; indeed, it shields the publican should he wish to make it, for it leads the consumer to infer that a beer which may have been diluted is a pure article, because it is stated to have been brewed from malt and hops. The Bill would compel the posting of a notice in a public house, either that the beer was brewed from malt and hops only, or that it was prepared from other ingredients, the nature of which would have to be stated. Now the construction and preparation of such a notice is, in the Bill, clearly vested in the hands of the brewer. It is not stated in the Bill that the publican is to state what the beer is prepared from, and it is clearly not intended that he should. The onus of such a statement rests entirely with the brewer. Now, assuming the general honesty of publicans, there might be no objection to the adoption of such a proposal; but it has been abundantly proved that some publicans, at any rate, are not above diluting their beer with sugar and water. Now assume that a dishonest publican, *i.e.*, a publican accustomed to defy the excise and dilute his beer, were to exhibit a brewer's notice stating that the beers sold in his establishment were brewed from malt and hops only, or that he had no occasion to post a qualifying notice, and that notwithstanding such a notice, or absence of one, the beer was tampered with by him; according to Mr. Quilter's arguments, the consumer would, by the posting of such a notice, or by its absence, know

that he was getting what he asked for, and it would not be unnatural that the average working man would conclude, upon the strength of such a notice, that he was given a glass of beer the purity of which was beyond dispute. Yet it is apparent in such a case as I have stated—by no means an unlikely or an exaggerated case—that he would not be getting the article he asked for, although by Mr. Quilter's Bill he would be led to infer that he was. In such circumstances, what security would the writing on the wall afford to the consumer, and how would it protect him? Would it not rather constitute a shield to cover the illicit practises of dishonest retailers? I think it must be admitted that this would be at least one of the results it would produce; and in such a case it would not protect the public, but, on the contrary, would constitute a premium upon beer adulteration.

Beer dilution is one of the chief reasons why bad beer is retailed to the public; but it is not the only one. Bad beer may be sold because it is badly brewed, or because it is made from low-class material. In neither case would Mr. Quilter's Bill improve the article as retailed, nor as brewed; for so long as the ingredients are not noxious, and do not fall within Mr. Quilter's third category, the Bill would not seek greatly to interfere with the quality of the material employed. It will not be denied that beer brewed from a low-class cheap barley-malt is much inferior to one brewed from ordinary barley-malt plus malt adjuncts, and it is far more likely to exert an injurious influence upon the system. Yet no restrictions are placed upon the quality of barley-malt employed. Nor does Mr. Quilter seek to place any restriction upon the quality of other ingredients, so long as it is stated that they are used in the preparation of the beer. Thus a very inferior sugar might be employed, and result in the production of a very bad beer. The consumer would consult the public house notice, and would find that the bad beer in question contained sugar. He would naturally be prejudiced against a sugar beer. But he would be unfairly prejudiced, because it would be possible for him to go to a neighbouring public house, where a beer was retailed prepared from a better class of sugar, and find that the beer was as good as need be drunk.

It is often misleading, from other causes, to infer that beer as sold in a public house represents the beer as delivered by the brewer. It may be drawn before it is fit to drink owing to pressure of trade, and in this way all its good qualities may be obscured. Beer should not be drawn before it has recovered from the effects of transit, and if it has perchance to be so drawn, it will taste more like "muck" than beer. But, above all, it is liable to be spoiled by defective working of the beer engines, or through the incompetence of the man in charge of them. It is well known that every barrel of beer contains a considerable amount of sediment, and if this is continually churned up by a faulty engine, or by repeated jerking, it is obvious that the beer will be disfigured by its appearance in the glass. All these considerations must be taken into account before attempting to condemn the brewer for bad beer retailed in public houses.

Another point demands brief notice, respecting the effect which Mr. Quilter's Bill would produce upon public house retailing. Publicans do not confine their sales to one class of beer; they sell several, such as bitter, mild, stock and old ale, stout and porter. Now, assuming Mr. Quilter's Bill were to become law, it is probable that some of these beers would continue to be brewed from malt adjuncts as well as barley-malt, and some would be brewed from barley-malt only; some would be brewed with rice, some with maize, some with lævulose, some with dextrin-maltose, some with glucose, some would contain antiseptic sulphites, and so forth. Hence the publican would require to post up not one notice but several, and often many. In some cases he would cover his walls with notices, and in small ale houses he would require an extension of premises in order to find room for them. This multitude of notices would lead to a confusion which would not favour the smooth working of the Bill; but it would be intensified when the consumer demanded, say, a pint of mild and Burton, or of stout and bitter, or of half-and-half, all of which blends, it will be admitted, are in common request by working men. In order to comply with the spirit of Mr. Quilter's measure, he would have to undertake a preliminary survey of the public house walls, in order that he might know what he was about to drink.

Let us next inquire whether the Bill would ensure the production of pure beer within the brewery.

It will assist us in arriving at a conclusion upon this question if we glance at the actual conditions under which beer is now produced in England. Under the Act of 1880, the Excise officer is virtual master of the brewery; every vessel and apparatus used has, for his

guidance, to be marked with letters signifying the purpose to which it is applied. The raw material, the beer in process of manufacture, and the finished beer, are open to his inspection at all times and at all hours. If necessary he may break through windows and doors in order to gain admission to the brewery. A return has to be made to him not only of what is used, but of what is obtained from that which is used. His duty consists not only in taking the final duty figures, but in watching the entire process to see that no fraud is practised upon the revenue. Every conviction brings him a certain amount of commendation from his Board, and often pecuniary reward; so that he has a direct interest in keeping his eyes open and striving to detect any departure from the defined regulations. The Excise have the power of placing a veto upon the production of any class of beer which may be considered by the authorities to be opposed to the public good. It is but a few weeks since they gave evidence of the possession of this power by forbidding the brewing of a beer, practically a weak solution of sugar slightly fermented, which certain brewers were supplying to the publicans, in order that the latter might defeat the efforts of the Excise to prevent the dilution of beer by the publican. The production of this beer was very properly prohibited on the ground that it opened the doors to fraud. Hence it will be seen that the duties of the Excise are not confined to the collection of beer duty; but extend to the supervision and control of the quality of beer produced. It will be readily granted by those who have had experience of the Excise officials since the working of the free mash tun Act that they have discharged their duty efficiently and firmly, and have materially contributed to the smooth working of the Act.

But the public are not only protected in this way against the use of noxious ingredients in the preparation of beer, they are, perhaps, more directly protected by a law, drafted with extreme care, with a view to prevent the use of harmful substances in preparations intended for human food. I refer to the Act 38-39 Vict., ch. 63 1875) and to an amending statute, 42-43 Vict., ch. 30 (1875). "Food" is defined therein as including every article used as food *or drink* by man other than drugs or water; the Acts provide that no person shall mix, colour, stain, or powder, or permit any person in his employ to mix, colour, stain, or powder, any article of food with any ingredient or material so as to render the articles injurious to health, with intent that the same may be sold in that state.

For every offence it imposes a penalty not exceeding £50 and costs, and after a first conviction, every subsequent offence being a misdemeanour, the offender is to be sentenced to imprisonment for a term not exceeding six months with hard labour. It would also be possible, under 37 and 38 Vic., c. 89, 55, and 38 and 39 Vic., c. 55, 116-119, to have bad beer seized and condemned as being "unwholesome provisions unfit for human food." Now, if these Acts, coupled with the other powers with which the Excise officers are armed, will not suffice to protect the public from the use of noxious substitutes in the preparation of beer, it is difficult indeed to see how Mr. Quilter's Bill can possibly effect it; more especially as it contains no provision to ensure the punishment of those brewers who issue fraudulent warranties.

If noxious ingredients are used in the preparation of beer, it is because the law is not enforced, and not because it does not exist in a sufficiently stringent form to ensure the exemplary punishment of offenders. Mr. Quilter has stated *(Nineteenth Century, loc. cit.)* that the use of noxious substitutes will not be denied. If he can substantiate his statement, he will prove the existence of his third category. But I venture to assert that no one acquainted with the inner working of a brewhouse is justified in stating that noxious ingredients are used in the preparation of beer. Mr. Quilter has been challenged by the organ of the trade to prove a single case in which noxious ingredients are employed. Till now he has confined himself to abstract statements respecting this matter, and has not furnished those confirmations which will assuredly be required before their accuracy will be generally accepted. I may, perhaps, be permitted to state that I have had a very large experience of all the ingredients used by the brewer, and I think I may safely assert that I am acquainted with every class of substance employed by him. It has been my duty to examine analytically and to report upon the purity of hundreds of samples submitted to me, and it is upon the strength of that experience that I venture to endorse the challenge of the newspaper I have quoted. I have had occasion to examine every class of product available to the brewer, and I can assert without the slightest hesitation, that I have never met with one that could by any stretch of imagination be

termed noxious to the human being. In making this statement, I do not even except the use of hop substitutes, which were undoubtedly employed in large quantity during the year of hop famine. I am not here to defend the use of hop substitutes, because the cheapness of hops, caused chiefly by imports from abroad, has altogether obviated the necessity for their employment. But even asssuming that quassia were, at the present moment, used for imparting the bitter flavour to beer, it would require either a bold or an ignorant man to argue that this substance, dispensed so largely by medical men, was more noxious than the bitter principle of hops now added. I will not detain you by reciting the historical facts in connection with the use of hops in brewing; I will merely remind you that there was a time when they were not employed at all. They may not be absolutely noxious, but they are certainly not an unmixed boon, and I am supported by very high scientific authority in the opinion that over-hopping of beer has more to do with the stupefaction produced by beer-drinking than has the alcohol contained in the beer.

Moreover, evidence has been furnished even during the last few weeks, that brewers do not and will not encourage adulteration. When the crusade of the Excise against beer dilution was commenced in earnest, and publicans saw clearly that they must either submit to heavy fines or stop the practice of beer dilution, they appealed to Brewer's-hall in the matter, and represented that the existing taxation was so oppressive that a reduction must be made in the price of beer to the publican, in order that an excuse for dilution might no longer exist. The company considered the matter, and replied to the effect that it could not acknowledge the principle of beer dilution, nor its necessity; but I am informed that, as the result of repeated deliberations, they have decided to meet the views of the publicans, and have officially announced a very material reduction in the wholesale price of beer; but have distinctly made that reduction contingent on efficient safeguards being taken, in conjunction with the Excise and the Licensed Victuallers' Protection Society, to prevent the mixing of beers, and to prevent adulteration and dilution.

Now it is scarcely reasonable, and it is unfair upon the brewer, to conclude that he would assist in the suppression of adulteration outside the brewery, and would sanction its practice in the brewhouse. It is tantamount to a charge of hypocrisy, which would not, I think, be preferred even by the bitterest enemy of the brewer.

We have seen that the powers of the Somerset-house officials are so ample as to be almost oppressively inquisitorial, if it is desired to enforce them to the fullest extent. We know that they are possessed of a most competent scientific staff, directed by one of the ablest chemists in England. We know that their duty is not confined to fiscal work, but that they have to inquire into the purity of food, and in that respect are the guardians of the public health. It cannot be denied that they are zealous and energetic, nor that a case of adulteration brought before their notice would receive prompt attention. And what do we find as the result of their labours? That the number of cases of adulteration of beer reported to them by the public analysts, and the number of convictions obtained in connection with these reports is considerably less than before the repeal of the malt tax. This is made clearly apparent by a perusal of the following returns:—

Table showing number of samples analysed by public analysts, and the proportion found adulterated before and since the transfer of the duty from malt to beer.

First.—While duty was charged on malt:—

Year.	No. of Samples. Examined.	Found adulterated.	Per cent.
1877-78....	666	62	9·3
1878-79....	999	50	5·0
1879-80....	434	16	3·6

Second.—Since the duty has been charged on beer:—

Year.	Examined.	Found adulterated.	Per cent.
1880-81....	465	19	4·1
1881-82....	326	8	2·4
1882-83....	..	..	5·5
1883-84....	402	8	2·0
1884-85....	494	14	2·8

In nearly all cases the adulteration has consisted of an excess of common salt.

Yet, in spite of all this, Mr. Quilter asserts that it will not be denied that noxious substitutes are employed in the preparation of beer. Such a statement constitutes a charge of incompetence against the Somerset-house officials. What evidence does Mr. Quilter produce to warrant such a charge? I can find none whatever. I merely find the quoted opinions of Mr. Young, public analyst, and of Dr. Bernays, the chemist to St. Thomas's Hospital. Neither of these gentlemen go so far as to assert

that the ingredients used are absolutely noxious, yet they would seem to be strongly of opinion that such is the case. Thus Dr. Bernays says (*Nineteenth Century*, January number, p. 130):—"As regards beer made from nearly all so-called substitutes, the effect upon the general health of the beer-drinking community is distinctly bad, and encourages, to my knowledge, the additions of gin and other mere alcoholics." If, however, noxious substitutes have been brought under the knowledge of Dr. Bernays, his position as a public analyst demands that he should have reported them to Somerset-house. As the result of inquiry, I find that he has not done so. He was, it is true, in the year 1878, concerned in a prosecution which charged a publican, who bought his beer from Messrs. Meux and Co., with having added salt thereto. But the prosecution broke down and was withdrawn; and since that time Dr. Bernays has been content with the expression of his opinion upon the subject; and it must be admitted that his views are totally at variance with those of specialists who have devoted years of study to the question.

The justification which Mr. Quilter possesses for stating that noxious ingredients are employed is slender in the extreme; but even if he be able subsequently to prove it to the hilt, it may fairly be asked how will his Bill prevent their employment? The power of preventing their use will still be vested in the Excise, and we have seen that they are already empowered to proceed in the matter. If it be proved that they are negligent or supine at the present moment—and I do not believe that it can be proved—why should we conclude that the passing of Mr. Quilter's Bill will make them less negligent or less supine? If, on the other hand, the ingredients are used fraudulently and surreptitiously by the brewer, how will the Bill prevent him continuing to use them? On the contrary, would it not rather encourage him to do so by placing it in his power to concoct a false warranty?

I have now dealt with Mr. Quilter's arguments. It is not as complete a criticism as I could have desired, but the time remaining at my disposal is required for the very serious purpose of discussing the views which the Right Hon. Henry Chaplin has expressed in connection with this Bill. Let us see, then, whether the passing of the Bill would confer a measure of protective relief upon the British farmer.

I take it that it would only confer protective relief by inducing the use of barley-malt in place of malt adjuncts, and to make such relief worth the seeking, it must be shown that the amount of malt adjuncts employed is very considerable. When we look at the malt adjuncts as a per-centage of total barley-malt, we find, however, that it is insignificant. It is difficult to get at absolutely exact numbers in reference to this question, because no returns are given of grain and cereals as distinguished from malt. They are all merged as one class, and what are known as brewing sugars are returned separately. I have, however, acquired data upon this point, which I am confident may be regarded as fairly accurate, sufficiently so, in any case, for the purposes of this argument.

Table of Brewing Ingredients employed during 1886.

			£
English malt, in quarters,	4,289,896 @ 39s.		8,365,297
Foreign malt,	,,	1,300,000 @ 41s.	2,665,000
Cereals,	,,	70,000 @ 53s. 3d.	123,375
Sugar,	,,	646,250 @ 25s.	807,812
			£11,961,484

The average price of the English barley-malt being taken at 39s. per quarter, the amount brewed represents an approximate annual value of £8,365,297; the average price of brewing sugars at 12s. 6d. per cwt., represents an approximate annual value of £807,812; the average price of unmalted cereals and ungerminated malt at 11s. 9d. per cwt., represents an approximate annual sum of £123,375; and the average price of foreign barley (best and common) at 41s. per quarter, represents an approximate annual value of £2,665,000. The approximate annual value of total malt adjuncts is, therefore, about £931,187, or only about one third of the value of the foreign barley, malted and used for brewing purposes in this country, It is, moreover, less than 9 per cent. of the total value of the English and foreign barley employed, or about 11 per cent, of the English barley-malt alone; so that, really, the use of malt adjuncts can exert but little adverse influence upon the British farmer, if we regard it from this point of view. It may, however, be reasonably urged that the annual quantity of malt adjuncts is increasing, and that somewhat considerably. The following figures, compiled from official sources, showing the amounts of sugar employed for brewing purposes during each suc-

cessive year for the last ten years, will prove this contention to be true :—

Year.	Sugar. Tons.
1876	43,814
1877	40,406
1878	56,000
1879	52,200
1880	66,029
1881	56,267
1882	57,109
1883	56,317
1884	59,304
1885	64,279
1886	66,347

Note an increase of 18 per cent. in sugar alone since the repeal of the malt tax.

It will be seen that, for the purposes of comparison, I have taken figures representing a fair present average. We, therefore, are confirmed in our conclusion that, if the British farmer is really injured by the use of malt adjuncts by the brewer, it can be but very slightly, and the pinch can be as nothing compared with that resulting from the mashing of foreign barley.

Now why do brewers use malt adjuncts? Is it on the score of economy? If, for instance, it could be shown that greater extracts were obtainable at a cheaper rate than from English barley-malt, the farmer might reasonably complain of a competition with which he could not cope. This is not the case. At prices now ruling, there is practically no saving to be effected; and certainly not such a saving as would induce a brewer to make any alteration in his method of work. It is true that the present price of malt is abnormally low; but so is that of sugar, and, from past experience, it is certain that a rise in the price of barley-malt would be attended by a proportionate increase in the price of malt adjuncts. Therefore, it will be admitted that the prices in the annexed Table are fair and representative. In order to be well within the mark, I have taken the average amount of malt adjuncts employed at 20 per cent. This is somewhat above the quantity generally used. Fifteen per cent. would be nearer to what is actually employed in the majority of breweries. However, taking 20 per cent. for all classes of malt adjuncts, and prices which fairly represent what is being paid for them by brewers, we arrive at the ollowing conclusion :—

Table showing Comparative Extracts and Prices of Barley-malt and Malt Adjuncts :—

Materials.	Average Prices.	Average Extracts.	Average cost per lb. of extract.
	per qr. s. d.	per qr.	d.
Best English malt	45 0	92 lbs.	6
Common ,,	36 0	86 ,,	5
Best Foreign ,,	47 0	86 ,,	6½
Common ,, ,,	35 0	84 ,,	5
	per cwt.	per cwt.	
Glucose	14 6	36 lbs.	5
Saccharum	15 0	36½ ,,	5
Prepared cereals	11 9	32 ,,	4¼

Cost per Barrel of 20lbs. of Extract from the Materials as specified.

	s.	d.
Best English malt	10	0
Common English malt	8	4
Best foreign malt	10	10
Common foreign malt	8	4
Best English malt, plus 50 per cent. of best foreign malt	10	5
Best English malt, plus 20 per cent. of glucose	9	7
Best English malt, plus 20 per cent. of saccharum (invert sugar)	9	7
Best English malt, plus 20 per cent. of prepared cereals	9	7
Common English malt, plus 50 per cent. of best foreign malt	9	7
Common English malt, plus 20 per cent. of glucose	8	4
Common English malt, plus 20 per cent. of saccharum	8	4
Common English malt, plus 20 per cent. of prepared cereals	7	11
Common English malt, plus 50 per cent. of common foreign malt	8	4

It is here clearly apparent that there is no appreciable saving to be effected by the use of malt adjuncts, certainly not such a saving as would tempt a brewer, unless it were accompanied by some other advantage.

The use of malt adjuncts too will vary very considerably with the locality of the brewery. This is shown by reference to the following Table :—

Table showing the number of bushels of malt to each cwt. of sugar used.

Counties.	Bushels.	Counties.	Bushels.
Middlesex	20	Sussex	23
Nottinghamshire	21	Hampshire	24
Glamorganshire	22	Northamptonshire	24

Counties.	Bushels.	Counties.	Bushels.
Gloucestershire	26	Cheshire	54
Kent	27	Wiltshire	54
(London)..........	28	Norfolk	55
Lancashire	28	Essex	55
Warwickshire......	29	Hertfordshire	55
Oxfordshire........	29	Suffolk	55
Somersetshire	30	Herefordshire	57
Devonshire	34	Carmarthenshire ..	63
Derbyshire	37	Yorkshire	70
Berkshire	40	Cumberland	76
Carnarvonshire	40	Staffordshire......	77
Cornwall	41	Northumberland ..	76
Worcestershire	42	Shropshire........	99
Leicestershire	45	Durham..........	126
Cambridgeshire ..	49	Montgomeryshire..	156
Lincolnshire	53		

These figures are particularly instructive when considered with reference to the quality of beer produced. I take it for instance that no one would argue that the beer brewed in Durham and Montgomeryshire is better than that produced in, say, Sussex and Kent. Yet clearly it should be so if the general public is to derive benefit from the provisions of the pure beer Bill. The following summary of a return moved for by Mr. Whitbread, M.P., has also an especial interest for us :—In England and Wales, there were used in the year ended September 30th, 1885, in brewing :—45,289,439 bushels of malt and corn ; 1,229,661 cwts. of sugar ; or, say, 36 bushels to one cwt.

Dissecting the portion of this return relating to the centre of " muck " production, we find that in Essex, Hertford, Norfolk, Bucks, and Suffolk, there were used in brewing* :— 2,767,468 bushels of malt and corn ; 50,398 cwts. of sugar ; or, say, 55 bushels to 1 cwt.

Hence it will be admitted that in the eastern counties, where it is stated that bad beer is retailed, far less adjuncts are employed than in those counties in which it will not be denied that good beer is produced.

I am acquainted with several gentlemen who are maltsters for sale. They have very extensive malt businesses, but, in addition, they have small breweries. Notwithstanding that they can obtain good malt at a cheap rate—presumably cheaper than the brewers to whom they sell it—yet they find it advisable to employ a certain proportion of malt adjuncts in their brewing operations. Indeed, they find that they cannot produce good beer unless they do so. It is not in their interest to handicap the farmer, or to use malt adjuncts at a dearer rate than they could use malt ; and yet they employ it. The answer to the question why they do so involves some chemical considerations, to which we will now devote our attention.

The starch contained in cereals varies in quantity and in the mode of its occurrence. Thus it has been shown (C. O'Sullivan, Trans. Chem. Soc., Jan. 1884) that the following average amounts are determinable in typical samples :—

Oats	about 38 per cent.		Wheat	about 55 per cent.	
Barley	,, 46	,,	Maize	,, 58	,,
Rye	,, 46	,,	Rice	,, 77	,,

In saying that it varies in its mode of occurrence, I mean that starch cells are subject to modification in physical and physiological properties. Thus it is possible to distinguish starch cells obtained from the various cereals mentioned, and from other products, such as potatoes, beans, &c., by examining them microscopically, and noting the contour and characteristics of the outer wall, which is essential to the structure of the cells. It will be found that the starch cells of beans, potatoes, rice, wheat, maize, &c., differ in this respect to a very remarkable extent, not only so far as the shape of the starch cell is concerned, but also with respect to its size.

Notwithstanding these physical differences, the chemical properties and constituents of the various starch cells are identically the same. The cell is an organised structure, and consists of an enveloping wall, known as amylo-cellulose, or amylo-dextrin, as it is now termed, and soluble cell contents known as granulose, or starch substance. There is a third constituent found in the interior of the cell, and is, I believe, common to all starches. Its properties have, however, been but slightly studied, and we need not dwell upon its future consideration. What is important for our purpose is to understand, and admit, that the starch granulose required for the purposes of brewing is identically the same in chemical

* Colchester collection includes parts of Suffolk and Essex.
Ipswich ,, ,, ,, ,, ,,
Hertford ,, ,, ,, Essex, Bucks, and Middlesex.
Lynn ,, ,, ,, Norfolk, Cambridge, and Lincoln.

So that the figures for above calculations were thus arrrived at :—

	Malt and Corn. Bushels.	Sugar. Cwt.
Colchester	817,687	15,434
Ipswich	316,191	8,057
Hertford	557,053	10,112
Lynn......................	211,355	5,004
Norwich	865,182	11,791
	2,767,468	50,398

properties, whether it be obtained from barley, wheat, maize, rice, oats, sago, or even beans and potatoes. In the process of brewing, the starch cell has to be operated upon before it can be made available in the preparation of beer, and for this reason. The amylo-cellulose wall is unable to diffuse through it a body which is required in order to exert an action upon the granulose, which shall convert the latter into brewing sugars. The only practical way in which the granulose can be brought into intimate contact with this body, is by the bursting of the amylo-cellulose wall, and the consequent release of the contained granulose. In practice this bursting of the cell wall is attained by subjecting the starch to the action of heat. Under its influence the amylo-cellulose swells enormously and ultimately bursts. This swelling and bursting constitutes what is known as the gelatinisation of starch. In the ordinary process of barley-malt brewing, this gelatinisation is effected within the mash tun itself, but in the case of some of the prepared cereals employed, a sufficient gelatinisation is effected by a most ingenious method prior to its use, so as to allow of the release of the granulose almost immediately upon its addition to the mash tun.

Now it is found—and it has been known for very many years—that if barley be subjected to what is called the process of malting, *i.e.*, a process of partial germination, there is developed in the barley a remarkable body which, under defined conditions, is capable of exerting a chemical influence upon starch granulose. The result of that influence is the production of what are termed brewing sugars. The remarkable body thus developed is called diastase. Whether it is an homogeneous body of constant composition, is not yet absolutely known. It would rather appear to be a mixture of two or more complicated bodies; but what is certain is this, that it is not found in barley (except in minute traces) which has not been malted. It is a nitrogenous compound, produced synthetically in nature during germination, and is built up at the expense of nitrogenous substances found in the original barley. O'Sullivan has succeeded in isolating diastase in the nearest approach to purity yet attained.

If some of this pure and freshly prepared diastase be brought into intimate contact with the granulose of any starch (rice, maize, beans, sago, or what not) at suitable conditions of temperature, and in the presence of water, which is essential, it is found capable of exerting upon this granulose exactly the same influence as it would upon the granulose of barley-malt starch. It will convert it into what we term brewing sugars. Therefore, assuming that the object of the brewer is to convert starch into brewing sugars, and that his barley-malt contains more diastase than is necessary to effect a conversion of its contained starch, it is justifiable to apply the surplus to the conversion of starch other than that contained in the barley. It is not only a justifiable proceeding, it is a scientific one, and, apart from certain technical considerations, with which I will not trouble you, constitutes the *rationale* of what is termed the raw-grain process of brewing. It is the discovery that diastase of barley-malt will convert more than its own associated starch that has practically led, among other applications, to the use of over 70,000 quarters of prepared cereals in the brewery during the last year. The quantity of diastase contained in barley-malt is subject to wide variation, but it is always present in great excess over that required to convert the starch in the malt. Dubrunfaut states that it is capable of converting from 150,000 to 200,000 times its weight of starch. Other observers do not give such a high figure, but all agree in stating that it contains more than is required for ordinary converting purposes.

Diastase is not confined to barley-malt. It occurs in other starch-containing materials which have not been subjected to the process of malting, as, for instance, in rye; but it has been found in practice that the best means of producing it is by partially germinating barley; and in brewing no other diastase has been found to be a successful substitute for it. The prepared cereals do not, as a rule, contain diastase, and if they do, it is negligible in its effect, and hence it will be seen that it is not practicable to use more than a certain amount of the substituted bodies, so that they could never wholly supplant barley-malt. The British farmer need not be uneasy upon this point.

The process of malting is not, however, merely confined to a partial germination of the grain. It also effects a modification in the starch cell, which renders it more susceptible to ready and immediate gelatinisation. It is argued, and I think with fairness, that inasmuch as this modification can be effected without accompanying germination, that rice, maize, and sago may be malted for the purposes of the brewer without being submitted to germination. It is this process

of malting without germination which is practised in the preparation of prepared cereals, and I maintain that their production is based upon scientific principles, the soundness of which cannot be impugned.

Now what is the effect of diastase upon starch? Starch is very complicated in its molecular structure. In ultimate composition it contains 180 atoms of carbon, 300 atoms of hydrogen, and 150 atoms of oxygen. These atoms are supposed to be associated in groups, the component atoms of which are held together by some intra-molecular attraction. The simplest group is represented by the formula $(C_{12}H_{20}O_{10})$. They are further assumed to be drawn together by some attracting which links each group in threes, and five of these groups of three are believed to constitute the complete molecule of starch. So that the complete molecule of starch is represented by the formula $[(C_{12}H_{20}O_{10})_3]_5$.

The action of diastase upon this complicated molecule, is, as its name implies, that of a cleaver. It is capable, under defined conditions, of causing a molecule of water to act upon one of those groups of three to which I have alluded, and in this way cleaving it, or in other words, of effecting its decomposition. Thus:—

$$(C_{12}H_{20}O_{10})_3 + H_2O = C_{12}H_{22}O_{11} + (C_{12}H_{20}O_{10})_2$$

(One of the groups of the starch molecule) + water = maltose + Malt dextrin.

The bodies thus produced consist of maltose and a less complicated molecular substance which I term malt dextrin. The diastase can further act upon this malt dextrin by the introduction of two molecules of water, and can effect its further degradation. Thus:—

$$(C_{12}H_{20}O_{10})_2 + 2H_2O = 2C_{12}H_{22}O_{11}$$

Malt dextrin + Water = Maltose.

This action is carried on throughout the whole series of five groups, and maltose may be formed from each successive degradation of malt dextrin, until we come to the lowest dextrin in the series $(C_{12}H_{20}O_{10})$, which is incapable of further change, even during the subsequent process of fermentation.

It will thus be seen that it is possible to form a whole group of dextrins, or to carry the action of the diastase far enough to leave only one. The number of dextrin groups which can be broken up is now to a very great extent at the option of the brewer. Each group has its own distinctive properties, and inasmuch as the dextrin remains wholly unattacked by pure brewer's yeast, and passes unchanged into the finished beer, and remains there unaltered, unless attacked by false ferments, it is found that the ratio of maltose to dextrin, and the nature of the dextrin formed in the mash tun, determines to a very marked extent the palate and properties of the finished beer.

It is the preparation of a solution containing a certain proportion of maltose and dextrin, which constitutes the brewer's wort, and so long as diastase is present in the mash tun it matters not, apart from certain mechanical considerations, whether the starch from which the maltose and dextrins are obtained, was primarily contained in barley or any other product. It makes no difference to the reaction, and it makes little or no difference to the properties of the beer. Apart from some other technical considerations which are involved, the object of mashing is to produce a solution containing a definite ratio of maltose to dextrin. When this solution is attained, the wort is hopped, cooled down, and is ready for the action of the yeast ferment. As the result of chemical investigation, it has been found possible, by acting with diastase upon starch, to make a preparation of dextrin and maltose which shall possess the properties of malt wort, but which shall be free from the objectionable substances of barley-malt wort, and in this way shall assist in diminishing their amount in the finished beer. It is found possible to exclude these objectionable bodies from the artificially-prepared compound. It is impossible to eradicate them in English barley-malt. How, then, can it be to the interest of the farmer that their use should be abolished?

The solution containing maltose and dextrin is in due course submitted to the action of yeast. The dextrin is unaffected; the maltose affords a nutriment to the yeast, and is what is termed a fermentable body; that is, it is decomposable by yeast. The result of its decomposition is to provide the nutriment of the yeast, and probably also the heat and energy necessary to its vital development. The principal excretive products of this vital development are alcohol and carbonic anhydride. But there is strong reason, amounting almost to certainty, for believing that maltose is not directly fermentable by yeast. The results of experiments leaves scarcely a doubt that it is, before decomposition, converted into a sugar known as glucose, and that glucose is directly fermentable by yeast. This has an important significance for us.

But maltose and glucose are not the only sugars readily available for yeast nutriment. If cane sugar be acted upon by acid at suitable temperatures, the excess of acid neutralised, the sugar solution filtered and purified by passing through animal charcoal, it is found that the sugar then produced is entirely different in properties to cane sugar. It acts differently towards polarised light and all its reactions are altered. but above all, yeast acts differently towards it. Whereas, before, the yeast attacked it with difficulty, the sugar is assimilated with rapidity; whereas the decomposition of cane sugar by yeast is followed by a weakening of the latter, it is found that the new sugar increases the vigour and vitality of the yeast. These remarkable changes are due to the fact that yeast shows a very decided preference in its choice of carbohydrate food. The action of acid upon cane sugar is to produce two carbohydrates, glucose and lævulose, both of which are directly fermentable by yeast. This action of acid upon cane sugar is termed inversion, and the sugar obtained, invert sugar; so that it really comes to this, that what the brewer takes all the trouble to produce from barley, through all the complicated stages of malting, the production of maltose, and its subsequent transformation into glucose, may all be obtained by the action of acid upon cane sugar; and, in addition, may be obtained the sugar lævulose, which is assimilated by yeast with activity, and which imparts to beer a condition scarcely obtainable from barley-malt, and certainly not obtainable at all within the same limits of time. This being the case, it is not a cause for surprise that invert sugar and glucose, also obtained by acting upon starch with acid, should be used by the brewer as malt adjuncts. They are practically identical with the fermentable mash tun products, and are obtained by a shorter road, which has been pointed out to the brewer by the chemist. But it is important to bear in mind that they cannot altogether supersede malt. They can only be used to a limited extent, for we have seen that good beer must contain a definite amount of dextrin compounds typical of malt extract. In good invert sugar and good glucose these latter bodies are absent, so that it would be impossible to substitute them altogether for barley-malt.

Raw sugar is used by the brewer rather on the score of economy than because of any scientific reason for its employment. It is not directly fermentable by yeast, but has first of all to be inverted in the fermenting vessel. The inversion is effected by invertin, a substance contained within the cell of the yeast, and, like acid, possessed of the power of hydrating sugar. The yeast cannot, however, part with this invertin without becoming greatly weakened. If, therefore, raw sugar is used, and it often is, means have to be taken for strengthening the yeast after it has effected the inversion. In any case, however, the object of the brewer is the same—the production of sugar directly assimilable by yeast.

My remarks, which have, through pressure of time, been far more general than I could have wished, will, I trust, have paved the way to an understanding of the difficult problem at which we have now arrived. Why and how does the addition of malt adjuncts allow of the production of good beer with the lower classes of English barley ?

Barley-malt does not alone contain the starch necessary to the production of a solution of maltose and dextrin. It contains, in addition, nitrogenous bodies, some of which are soluble, and some of which are insoluble in hot water. The insoluble bodies being embodied in the grains recovered after washing, need not further concern us. The soluble bodies contain diastase, but, in addition, a number of extremely complicated substances which would seem, one and all, to exert an influence upon the finished beer. Diastase does not pass as such into the finished beer, or, at any rate, not in active condition, its converting power being destroyed by a raising of the temperature directly it it has effected the necessary transformation of starch. A certain quantity of the nitrogenous substances are required for yeast assimilation, and it would be found impossible to brew a beer of good quality from a wort devoid of nitrogenous bodies. This furnishes another reason why malt adjuncts can never wholly supersede barley-malt.

But in every case barley-malt contains more soluble nitrogenous matter than is required for yeast assimilation. In this I am confirmed by the statements of Valentin (see *Journal of the Society of Arts*, March 24th, 1876, vol. xxiv., p. 404), and by the fact that all finished beer, whether brewed with malt adjuncts or without them, contains a relatively large quantity of soluble nitrogenous matter. It has hitherto been the custom among chemists to regard all this soluble nitrogen, of wort and of beer, as what is termed albuminoid nitrogen, that is, it

has been supposed to represent so much soluble albumen; and it has been frequently stated that a malt rich in soluble albuminoids is ill-fitted to the production of sound keeping beer. It has further been stated that English barley-malts contain more soluble nitrogen than do foreign barley-malts. The analyses and the assertions are alike inaccurate. Foreign barley-malts, as a rule, contain more soluble nitrogen than English, but it is only a certain proportion of the soluble nitrogen of barley-malt that is referable to albumen. In truth, the soluble nitrogenous bodies contained in malt wort are as numerous as they are complicated. It is not possible, in the present state of chemical knowledge, to isolate them all, but it is possible to differentiate them into groups or families of nitrogenous bodies, possessed of similar if not identical properties. The soluble albuminoid of malt wort may be entirely precipitated by neutral lead acetate, but if the precipitate is filtered, the clear solution will still contain nitrogenous bodies, and that in notable amount. The groups of soluble nitrogenous bodies found in malt wort may be divided and separated as follows:—Albuminoids, peptones, amides, and unknown nitrogenous compounds. Of these groups, it has been proved by Griessmeyer and others that amides, which are formed at the expense of albuminoids, constitute by far the best form of yeast nourishment much better than the peptones, which have some claims in this direction; so that the sum of the peptone and amides would very closely indicate the nitrogenous yeast-feeding power of the wort.

Now, with respect to the unknown nitrogenous bodies, that is bodies which cannot be referred to albuminoids, peptones, or amides, I have proved this most important fact—they are soluble in brewing sugars, and they are precipitated by alcohol. Assume, now, these unknown bodies to be present in an English beer, as they generally are, what would happen? The maltose of beer wort is never entirely consumed during fermentation. The beer would be too dry if this were allowed to happen, and the beer is never free from yeast cells, which are conveyed into the cask or bottle; so that we have present conditions favourable to the continuance of an after fermentation—as it is called—and this, after fermentation, is not regarded with disfavour by the brewer. It brings the beer into condition.

But this fermentation involves the gradual production of an increased quantity of alcohol, which precipitates the unknown nitrogenous bodies as it is generated. The quantity of unknown nitrogenous bodies is very small in amount, and so is the increase of alcohol, so that we do not get a bulky precipitate formed which would fall to the bottom of the cask and clear the beer; we get it formed as a thin cloud which, gradually increasing, at length obscures the brilliancy of the beer and determines what is termed its "sickness." It is obvious that there are two ways of remedying this evil. To dilute the wort with malt adjuncts, which contain none of those unknown bodies, so that the amount of the latter becomes negligible, or to have present in the beer a certain quantity of brewing sugar, which will keep them in solution. I do not say that every case of beer sickness is traceable to the cause I have indicated; but I am very confident that in the majority of instances it will be found to be so.

The quality of nitrogen in malt exerts, then, a remarkable influence upon the beer brewed. What is it that determines this quality of nitrogen that is found in the malt? Undoubtedly it is the soil upon which the barley is grown, and the climatic conditions to which the latter is exposed during the period of its ripening. These conditions are most unfavourable in England; they are most favourable in sunny climes.

It has been abundantly proved by Gilbert and Lawes (see lecture delivered at the Royal Agricultural College, Cirencester. June 29, 1886) that barley derives its nourishment from the surface, and not from the depths of the soil; it derives its nitrogen from the same source. Now, it is probable, indeed, almost certain, that the quality of nitrogen assimilated from a surface soil, to which has been added artificial manure, will not be the same as that assimilated from soil in which the quality and amount of nitrogen has been determined by natural agencies. The British farmer has been desirous of obtaining yield per acre, and has not had brought to his notice the fact that this does not, from the brewers' point of view, coincide with quality of beer per barrel. Hence it is that so much foreign barley is employed for brewing purposes, and why so much more would be used were it not that malt adjuncts cover a multitude of sins. The truth of my remarks will be apparent from the following analysis, performed upon typical samples of good and common English, upon Scotch, French, Danish, and Moravian barley-malts:—

ESTIMATION OF SOLUBLE NITROGENOUS CONSTITUENTS OF MALTS.

Results expressed in per-centage of dry samples.

Malt.	Total Nitrogen.	Albumenoid Nitrogen.	Peptone Nitrogen.	Amide Nitrogen.	Unknown Nitrogen.
English (good)	·6148	·1200	·0340	·4059	·0549
English (common)	·6167	·1441	·0074	·3804	·0848
Scotch (average)	·5404	·0514	·0149	·4025	·0716
French	·7147	·1047	·0624	·5000	·0476
Danish	·7111	·1393	·0634	·5084	none
Moravian	·6159	·1435	·0438	·4286	none
Or expressed in percentage of the total nitrogen.					
English (No. 1)	...	19·51	5·53	66·02	8·94
English (No. 2)	...	23·36	1·20	61·68	13·76
Scotch	...	9·51	2·75	76·33	11·41
French	...	14·64	8·73	69·95	6·68
Danish	...	19·59	8·91	71·50	none
Moravian	...	23·30	7·11	69·59	none

Analyses of all-Malt Beer, and of Beer brewed from Malt + 33 per cent. Sugar.

	Original solid matter in wort.	
	All Malt.	Malt and Sugar.
Substance fermented	53·48	60·62
Maltose unfermented	16·06	18·52
Dextrin ,,	13·09	12·01
Other substances, hop, &c.	17·37	8·85
	100 00	100·00
	Grammes per 100 cub. centimetre.	
Alcohol	3·80	4 15
Total Nitrogen	·1050—	·0560—
Albumenoid	·0126	·0070
Peptone	·0164	·0070
Amide	·0692	·0367
Unknown	·0068	·0053
	·1050	·0560

I will not detain you by commenting upon these results. It will at once be seen how favourable they are to foreign, and how unfavourable to low class English barley-malt. Moreover, it cannot be denied that English barley-malt has, within the last twenty years, deteriorated, and not improved for the purposes of the brewers. I do not state this as the result of my own experience, because it does not go back so far; but I have conversed with numerous authorities, who have stated such to be the case.

Why is foreign barley used at all in brewing? not because it is cheaper—in most cases it is dearer—not because it gives a higher extract; because, as a matter of fact, it gives considerably less. The reason is to be found by reference to the Table I have quoted, and I do not think it can be ascribed to any other. Why is so much foreign barley used in those breweries where all-malt beer is produced? That such is the case will not be denied. Because it does not contain those objectionable unknown nitrogenous bodies so characteristic of low class English barley-malt, and which must be diluted or obscured to prevent subsequent damage to the beer. The imports of foreign barley are enormous; thus in the year 1885 it amounted to 15,391,000 cwts.; the quantity of home-grown barley in the same year was 67,502,000 bushels. Taking the average weight of the latter at 40 lbs. per bushel, we arrive at the following result: — Foreign barley, 15,321,000 cwts.; home-grown barley, 24,107,857 cwts. So that already foreign barley is imported in the proportion of say 40 per cent. of the whole available yearly supply. The quantity is increasing, but who can say, after studying the question, that the imports have not been held in check by the very use of malt adjuncts, which appear at first sight to have acted prejudicially to the farmer. I trust I may have succeeded in making this fact clear to you. If not, believe me, it is not for lack of proof, but for lack of reasoning power.

I have now touched upon most of the ingredients other than barley malt-used in brewing. I have only a few words to say about the use of mineral ingredients. The substances in question are few, and are absolutely harmless in the quantity in which they are employed. They are either antiseptics, in which case they are used because it has been found that, whereas their presence is fatal to false ferments, they do not injure pure yeast; or they are ingredients for addition to brewing water. It is found that the mineral constituents of water exert a very marked influence upon the beer brewed. Hence it is possible, by the suitable treatment of brewing liquor, to bring it up to the standard of the most celebrated brewing waters, and thereby enable a brewer to produce several kinds of beer with the same class of water. Inasmuch as the brewer only adds the very ingredients found in these waters, if he were to add an excess, he would defeat his object. I do not think it will be argued that this can constitute adulteration. To the

arguments that beer produced from malt adjuncts is more alcoholic and less nourishing than all-malt beer, I have only time to answer by producing the following analyses. They, in themselves, will show how groundless is the assertion:—

In per-centages on original solid matter in Wort.

Material.	Malt plus Sago.	Malt plus Rice.	Malt plus Glucose	Malt plus Dextrin-Maltose.		Malt plus Lævulose.		All Malt.	
Substance fermented	63·6	61·2	60·0	55·8	60·0	70·0	64·3	61·5	61·3
Maltose unfermented	9·9	13·6	14·4	14·4	13·1	8·7	14·4	7·1	8·8
Dextrin ,, ...	16·9	15·1	13·0	19·7	16·1	11·7	11·4	13·0	13·9
Other carbohydrates—ash, nitrogen, and hop matters, &c.	9·6	10·1	12·6	10·1	10·8	9·6	9·9	18·4	16·0
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

Table showing Soluble Nitrogen in Malt and various Malt Adjuncts.

English malt	·675	per cent.
,, ,, ...	·563	,,
,, ,, ...	·348	,,
,, ,, ...	·335	,,
,, ,, ...	·225	,,
,, ,, ...	·368	,,
Malt adjunct	·112	,,
,, ,, ...	trace.	
,, ,, ...	none.	
,, ,, ...	trace.	
,, ,, ...	trace.	
,, ,, ...	none.	
,, ,, ...	none.	
,, ,, ...	·227	,,

Average amount of Alcohol in various Beers.

All malt—		
Pale ale	5·02	per cent. absolute alcohol by weight.
Light dinner ale........	4·73	,,
X mild ale	5·00	,,
Malt + sago—		
Light dinner ale........	4·50	,,
Malt + rice—		
Pale ale	4·82	,,
Light dinner ale........	4·45	,,
Malt + saccharum—		
Light dinner ale........	4·20	,,
Malt + maize—		
Light dinner ale........	4·32	,,
Pale ale	4 93	,,

I have made many other experiments which I had hoped to bring before you, but which want of time forbids my doing this evening. I have secured for the purposes of this paper typical samples of all the products used in brewing, and I have submitted them to analysis. Some of the samples are before you, and I will give some to those who may wish to analyse them. I have proved their purity, and I would, did time permit, prove it to you to demonstration. I trust, however, I may ask you to accept my statement, and to believe that the purification of these products has now reached such a state of perfection as to demand the constant supervision of skilled chemists in the factories producing them, in order that they may meet the requirements of brewers. If they are not free from the objectionable ingredients of barley-malt, there is no logic and no object in using them. Assuming the accuracy of my experiments, the conclusions to be drawn from them are obvious.

The abandonment of malt adjuncts in brewing will not assist the farmer. It will hamper him, because it will lead to the use of barley-malt, in which the unknown nitrogenous constituents are absent. Such is the case, as we have seen, with foreign barley. The friends of the farmer are, as Mr. Chaplin says, seeking to remedy the existing state of things. I may be permitted to suggest a remedy which will lead to the greater utilisation of English barley. It is one which will take some time to apply with success; but once applied, it will be permanent in its relief. There is no reason why the unknown nitrogenous bodies to which I have alluded should not be capable of conversion into beneficial nitrogenous bodies under special conditions of malting. Our knowledge of the changes which nitrogenous bodies undergo during malting is paltry in the extreme. What encouragement is afforded in this country for the detailed

study of such problems? None whatever. On the Continent you can number agricultural scientific research stations by the score—in England you can almost count the number of agricultural chemists on the fingers of the hand. On the Continent most of the maltsters are scientific men. In England most of them are empirics, and are helpless in face of difficulties, such as I have mentioned. It is in this that relief is required. Let the friends of the farmer stimulate scientific research in connection with agricultural industry, and I submit, with respect, that efforts in this direction will bear better fruit than any pure beer Bill which political ingenuity could devise.

And now, gentlemen, I will not further trespass upon your patience, which must be well nigh exhausted. I trust I have placed the matter before you in an impartial manner; to do so has been my earnest and sincere desire. If I were weighed by personal considerations, I should advocate Mr. Quilter's Bill, and not oppose it, for if it pass, assuredly will more bad beer be brewed than at present, and this would lead to an increase in my consulting practice. But the arguments which I have placed before you are conceived in a spirit far removed from the regions of personal consideration. They are based upon the scientific labours of men whose names will occupy an honourable position in the history of chemical science; and it is with the firm conviction that these arguments will be treated by you with the respect to which this reflection should entitle them, that I respectfully commend my paper to your earnest and critical attention.

In conclusion, I beg to offer my thanks to Mr. P. T. Crockford, and other gentlemen, for the assistance received from them in conducting the experiments relating to this paper.

Appendix.

Summary of Inland Revenue Act, 43 *and* 44 *Vic.*, *c.* 20.

Repealing all the various malt duties from George I., 1 c. 2 to 38 and 39 Vic., c. 23, say from the beginning of Hanoverian dynasty to date of its passing, 1880.

It defines beer to be "ale, porter, spruce beer, black beer, and any other description of beer," and sugar as "any saccharine substance, extract, or syrup," inclusive of "any materials capable of being used in brewing except malt or corn."

On October 1st, 1880, malt duties ceased, and so did all duties on sugar used by brewers for sale, and a tax was levied upon every thirty-six gallons of worts, of a specific gravity of 1057°, of 6s. 3d., and so in proportion for any difference in quantity or gravity.

Forty-two hundredweight of malt or corn of any description, or twenty-eight hundredweight of sugar, are now deemed the equivalent of a bushel of malt.

A degree of gravity was defined to be equal to $\frac{1}{1000}$ part of the gravity of distilled water at 60° Fahr.

A brewing-book, to be delivered by Excise officer to every brewer, who was to receive entries of the proposed times of brewing, and of the quantities of malt, corn, or sugar, intended to be used, twenty-four hours before said brewing began; penalty of neglect £100.

All vessels, rooms, and positions of vessels to be legibly painted with oil colour, and numbered progressively.

Every stage of every brewing is to be watched, and officers may take frequent samples; penalty of concealment or falsity £100. Entry may be made into premises at any hour of day or night, by breaking open doors, windows, or walls; penalty of obstruction £100.

A table scheduled shows mode of determining original specific gravity of worts of beer:—*e.g.*, 1° of spirit indication = 3° of original specific gravity.

Customs and Inland Revenue Act (48 *and* 49 *Vic.*, *c.* 51., *a.d.* 1885).

Extends the term beer, in 43 and 44 Vic., c. 20, to any liquor which is made or sold as a description of beer, or as a substitute for beer, and which is found on analysis to contain more than 2 per cent. of proof spirit.

And provides that a sugar store is to be entered by the brewer for sale and accounts accurately kept, under a penalty of £50.

Retailers may add nothing except finings, and may not dilute; penalty for so offending £50.

DISCUSSION.

The CHAIRMAN said there might perhaps be some present who did not agree with all that had been said by Mr. Salamon, but he was sure there was not one who would not join heartily in thanking him for the interesting, able, and instructive paper he had read. He (the Chairman) did not come there as an expert in brewing; but he should certainly go away better prepared to act intelligently in the House of Commons when dealing with a subject which, whether they agreed with beer-drinking or not, should at least be treated in an intelligent manner. He was sorry he did not see his friend Sir Wilfrid Lawson there, as he intended to be, or Mr. Quilter either, who he thought could not fail to profit by the paper. There were two Bills dealing with the question of pure beer to be introduced into Parliament this year, and it was quite evident, from what had been said, that the purity of beer was not to be

secured in the way some people thought; they had also learned from statistics, and from the careful analyses made by a gentleman who had devoted some years to the subject, that it affected one of the most important classes of the community, and this was a time when that class—the agricultural—was more seriously affected than at any previous period. If it were the object of some of his colleagues in the House of Commons, in introducing these Bills, to promote the interests of the British agriculturists, they should study this paper thoroughly before giving their votes, and he hoped it would be widely circulated amongst them.

Mr. R. BANNISTER said it would not become him, in the position he held, to take any side on the question of the Pure Beer Bill, but having had a good deal to do with beer and brewing for the last twenty-five years, it was only right to say that he did not believe anything was put before the public in a purer state than the article produced by the brewer. He had had a great deal of experience, having had to examine thousands of samples sent up by inspectors from all parts of the country, and that was the result of his observation. One remark he might make on the Table showing the adulteration of beer (see *ante*, p. 254). The earlier figures showed a higher percentage than those below the middle line, but those per centages did not indicate the actual amount of adulteration practised in the present day, but were too high. He had studied the returns, and found they were nearly all the statements of gentlemen who had not gone into a court of justice for the purpose of proving whether the beer in question was adulterated or not. The detection of chlorides in beer was a very simple thing, but up to the present moment nothing was done in a more loose way than that simple analysis. Many years ago he pointed out in the *Brewers' Journal* that in order to detect the chlorides an alkali must be used for the purpose of fixing them; but, unfortunately, in nearly all analyses made for the purpose of comparison, this was not done, and, therefore, the statement was made—"chlorides, *nil*," when it was nothing of the kind. The precaution is now generally taken to fix the chlorides, and consequently the quantity now found is greater than formerly. In some of the Yarmouth ales the quantity of chlorides was about 120 grains to the gallon, derived either from the water or from the materials used—principally from the former. It was very improper, therefore, when a sample was found to contain a certain quantity of chlorides, nothing being known as to their origin, to say distinctly that they had been added by the brewer. From his experience, he should say that 99 per cent. of the samples which were reported to be adulterated by the addition of salt—that being the most common allegation—were not so, the chlorides being derived from the water, the malt, or the malt adjuncts, and not added by the brewer at all. With regard to the adulteration which had no doubt been going on for a long time in London, though attention had only recently been directed to it, he thought Mr. Salamon made rather too strong a point. Looking at the large sums paid for public houses, he thought the brewers had acted very wisely in reducing the price of their beer, for, on the old prices, the publicans did not make sufficient profit. It was only right, as practical men, to look things fairly in the face, and remedy the evil, if possible. With regard to Mr. Quilter's article in the *Nineteenth Century*, anyone who studied this paper would see that the three classes he mentioned could not be distinguished at all. A skilful man would produce a very good article though he used only a very small quantity of malt; whilst another who used all malt might produce a bad article by reason of his want of skill. A number of brewers, small brewers especially, who used malt only, he believed produced the article which Mr. Quilter called "muck," and not those who brewed with skill from malt and other materials.

Mr. T. CHRISTY remarked that Mr. Salamon had devoted all his attention to the brewers, and the consumers had been rather scantily treated. It was a well-known fact that beer did not agree with everyone, particularly those who had to work with their brains. He should like to ask if the German Government forbade the use of glucose. It was perfectly true, as had been said, that it was the properties of hops which produced headache after drinking too much beer; but he could not quite agree that the public were so efficiently protected against adulteration by the Excise as seemed to be assumed. There were large quantities of flints being calcined down the Thames, and he was informed that, when powdered, these were used to adulterate pepper, owing to its high price, notwithstanding that pepper was an exciseable article. The great object in brewing now-a-days was to make beer which would keep, and it struck him that that might be the reason why people could not digest it; producing, as it does, an immense amount of diabetes by drinking what is called "stodgy" beer. The Americans had been obliged to discover a means of brewing a thin beer which did not disagree with people. He had asked many brewers if he could get a pure beer made simply from malt and hops, just to try, but could only find two anywhere round London who could supply him with it. They all told him why they used glucose; but the question was, what was its effect on the system? He held there was hardly any worse thing, and that was why there was such a demand in America for *Syzygium jambolanum*, a new drug from India, which was said to counteract the effect of glucose on the system. Purity in a chemical sense was not everything, for distilled water was not at all a wholesome beverage—ordinary water was much better. It would be a great thing if Mr. Salamon, who had gone so thoroughly into the subject, would look at it more from the consumer's point of view, and get some medical man to assist him in finding out how to

alter some of these nitrogenous substances, and prevent them disagreeing with people. It was well known that, now-a-days, young men in the City, instead of taking a glass of beer with their luncheon, called for tea or coffee, because they found these more wholesome; so that, if a more digestible beer could be produced, he had no doubt it would be to the interest of the brewers.

Mr. VALENTINE L. LOVIBOND said he believed that both Dr. Pavy and Dr. Harley, who had paid special attention to diabetes, recommended the drinking of good, pure beer in that complaint. They found that if they obtained pure sugar, which was converted largely into alcohol, leaving very little sugar other than grape sugar, that beer was advantageous. On the other hand, glucose beer, with very little alcohol, contained that which might be converted in the stomach into a sugar which was not digestible, and would be injurious in such a disease. Good beer, however, like light claret, sherry, or dry champagne, was beneficial, and for this reason they preferred the English to German beers.

Mr. F. C. ADAIR ROBERTS said there was one point in connection with the proposed Bill which had not been much touched upon, and that was the interference it was likely to cause in the trade. There was a prejudice in the public mind that beer should be made only from malt and hops, and if this Bill were passed, it would interfere greatly with the trade in brewing-sugars, cereals, and other things used as substitutes for malt. It would only be a temporary interference, of course, for as Mr. Salamon had shown, these things were absolutely necessary. The Legislature, however, ought to be very cautious about passing a measure which would cause this interference; it should be proved beyond question that adulteration was widely practised before such a Bill was passed; but the fact was that Mr. Quilter had not brought forward a single instance of such adulteration.

Mr. PERCY HOSKINS said he regretted the absence of Dr. Bernays, whose character as an analyst was unimpeachable, and though Mr. Salamon might be correct in saying that the prosecution which he referred to fell through, he believed the fact was that it was undertaken on account of the excessive quantity of chlorides in the beer, but that this was found on analysis to be, not sodium chloride, but potassium chloride, not caused by the addition of salt, but probably derived from some impure saccharine used in brewing. He believed that the prosecution did not fall through, but that a compromise was effected, the brewers paying the expenses, and undertaking not to use such impure saccharine again. He, however, had the facts only second-hand, and could not be certain about them.

Mr. E. G. HOOPER said this paper would be very instructive and useful to analysts in judging of different samples of beer. He would say a word first on the general character of the beer brewed in England, and next on Mr. Quilter's Bill. He quite agreed with Mr. Salamon as to the general purity of the beer brewed in this country; the very small per-centage returned as adulterated spoke for itself; and in the next place, even the adulteration alleged —the addition of salt—had been, to a great extent, accounted for. Those cases of adulteration of London beer which had led to prosecution consisted only in the addition of sugar and water. He thought, however, the brewers might do a great deal if they would stop adulteration by the publicans. No doubt they did charge too high a rate, and next, if they would add their finings to the beer before they sent it out, the casks being properly shived down, on the return of these casks, any indication of the bungs having been removed would be evidence that something had been done to the beer. He was inclined to think that the "muck" Mr. Quilter referred to was most likely a genuine beer; at the same time he could not agree that it was impossible to brew thoroughly satisfactory beer from all malt, and thought many brewers did so. Again, he thought it was a little straining a point to say that under Mr. Quilter's Bill it would be necessary to describe bisulphite of lime as one of the materials from which the beer had been brewed; nor did he think the use of bisulphite was to be recommended. He took it that the use of this and other antiseptics was an indication that the brewer did not take quite so much care of his plant, &c., as he should do. The first test which should be applied to any Act of Parliament, however, was whether it would work, and the remarks of Mr. Salamon had clearly shown, though not perhaps with sufficient emphasis, that if the Act were passed, it would be quite inoperative. In very few instances, indeed, would any competent chemist take upon himself to say that a given sample had been prepared from malt only, or from malt with the addition of something else. The sugar which Mr. Christy had so much fear of, usually disappeared almost completely in the fermentation, and, in fact, glucose was one of the sugars which disappeared most readily.

Mr. JAS. WIGIN (Bishop Stortford) said, as Vice-Chairman of the Country Brewers' Association, he should not like to leave without thanking Mr. Salamon for his able paper. He would also remark that, as lager beer was made a good deal from rice, it would be very unfair to allow that to come into the country in large quantities whilst English brewers were not allowed to use the same materials. He was present in the House of Commons when Sir Arthur Bass and Mr. Watney spoke on this question, and Mr. Gladstone then gave the assurance that the free mash tun was to be the compensation for the extra duty put upon beer. It would be very unfair, therefore, to continue the extra duty, and take away the compensation which had been given for it. He could not help thinking that Mr. Quilter had not very well studied this subject. He remembered

talking with Baron Dimsdale, who then had a Bill which was withdrawn, and he drew the conclusion, from the conversation he had with him, that the thing had been rather rushed, and that they did not quite understand what the purity of beer meant. He was, therefore, all the more indebted to Mr. Salamon for the masterly manner in which he had treated the question.

Mr. Frank Bower remarked that antiseptics were not used for the purpose of killing germs which might be found in vats not properly cleaned, but for stopping fermentation at the desired point.

Mr. Jasper More, M.P., said the use of rice, which Mr. Wigin had referred to, was one of the things which farmers most objected to, maize being another. That gentleman's observations showed that the question was one between the brewer and the farmer.

Mr. Wigin said he knew a great many experiments had been tried with rice, and to a certain extent it was a success, although Mr. Salamon had not alluded to it; but he did not use it himself, and it must not be inferred because any gentleman referred to any particular article that therefore he used it himself.

Mr. Jasper More, said it was perfectly well known that at the time Mr. Gladstone removed the malt tax an additional million had to be found, and that had never been removed from the brewers. He was surprised brewers had never agitated to have the burden removed. With regard to the substances which farmers objected to as adulterants, he wished to point to sugar, which figured so largely in the Table, and to ask Mr. Salamon whether he considered it an adulteration or not, because farmers certainly did. He could only say that in his own house he had beer brewed without any sugar—simply from malt and hops—and he wished any gentleman present would do him the favour of coming and trying it. Not only so, but the labourers for whom he obtained the privilege of brewing used no sugar, and they produced a perfectly good article.

Mr. John Fordred thought any Bill which sought to secure the purity of beer should start by giving a definition of pure beer; but he believed the fact was there was no definition of any article of food or drink, except gin. Until such definitions were given, it would be very difficult to conduct a prosecution, and he believed a time would come when such definitions would have to be made, in order to carry out the Adulteration of Food and Drugs Act.

The Chairman said he had listened with great pleasure to the discussion, and had derived great profit from it. He should go away feeling that he could not support either of the Bills now before Parliament to promote the purity of beer, although no one was more desirous of obtaining that object.

Mr. Salamon, in reply to Mr. Jasper More, said he must be pardoned for saying that that gentleman must have misunderstood many of his remarks. The sugar in the Tables did not by any means represent what was in the beer, when brewed. He had taken some pains to try and make it clear that the addition of these substances did not imply the presence of them in the finished beer; but of substances which were chemically identical with those which were obtained from barley-malt. The reason the brewer used them was not because they were cheaper; no brewer used more than about 20 per cent., and he had no interest in doing so, so far as his pocket was concerned; it was unfair to him, to those who supplied him, and to the consumer, to say that the beer contained rice, maize, or glucose; it contained nothing of the sort, but it did contain the decomposition products of those materials, and those were the same, whether made from barley-malt, or from those substances. What he wished to emphasise was that these very substances would not be used by the brewer unless they were free from the objectionable bodies which characterised low-class English barleys. He had not alluded to the question of the capital invested in public houses, because it was not within his province; he came there to speak on the chemical aspects of a public question, and tried as far as possible to confine himself to that. The brewers had most fairly met the publicans, who said they must either get their beer cheaper or dilute it; whereupon the brewers said we cannot countenance such a thing as dilution, you shall have the beer cheaper. With respect to the employment of glucose in Germany, he was not absolutely certain, but as far as his knowledge went, malt adjuncts were totally forbidden in Bavaria, but were used in all other parts of Germany. The celebrated Pilsener beer, as far as he knew, and most of the celebrated German beers were brewed with a notable proportion of malt adjuncts. Most of our chemical knowledge, except that derived from Burton, and from such famous chemists as O'Sullivan, Heron, Browne, Griess, and so forth, was obtained from German chemists, who had made researches at Brewing Institutes, encouraged and maintained by brewers, in order that they might master the chemistry of their science. The question of diabetes in connection with beer was a novel one to him, and he did not know whether beer would be bad or good for it; certainly glucose could have nothing to do with it, because the glucose was all gone before it reached the consumer. What might be the effect on the digestive functions of these nitrogenous matters he could not say beyond a certain point; probably some of them were good for the system, and some bad. He thought he might safely say that peptones were good, and amides might also be acceptable, but what might become of those unfortunate unknown bodies he could not say. He was not prepared to deny that young men in the City went in for tea and milk, nor could he say what were the chemical reactions which led to their doing so;

but Mr. Christy would admit that there was a time when gentlemen used to drink two or three bottles of port wine at dinner, and that now they took claret—that they had in fact changed their habits very considerably. Things were approximating in England to the production of beer somewhat on the German lines. Brewers were now making experiments with that object; but it was a mistake to suppose that German beer contained less alcohol than English. It would be found, as a matter of fact, that the intoxicating effect was no greater in English beer than in German, unless you took a very heavy pale ale, and if you compared that with the *salvata* beer of Munich, the German would be found to be stronger. It would seem to depend on the process of manufacture, and no doubt that process was being modified in accordance with the spirit of the time. He would be the last to say anything disparaging of Dr. Bernays, for whom as a chemist he had the greatest respect; but he could not disguise from his mind the fact that Dr. Bernays' studies had covered a great multitude of subjects, and when he found a gentleman occupying the position of a public analyst stating in print that beers brewed from so-called malt substitutes contained more fusel oil than those brewed from barley-malt, and when he extracted the alcohol from them and found that such was not the case, he did not wish to say that Dr. Bernays was wrong, but merely that they differed, and he thought that difference had better be made known. With regard to the prosecution referred to, he was quite correct in saying it was withdrawn, for he had in his hand a copy of the *Brewers' Journal* containing an article on the case written by a gentleman who was prepared to give evidence on the subject, in which he stated what he was prepared to prove in Court had not the prosecution been withdrawn, so that, on the strength of that, he thought he was justified in making the statement. With regard to the question about the use of bisulphite of lime, he might remark that he had not said a word against it; to go into the question whether it should be used or not would take a very long time, but he was quite safe in saying that many millions of barrels of beer had been consumed which contained bisulphite, and it had been proved for many years that it was quite harmless. He would also say emphatically that beer, as retailed, if made without malt adjuncts, must contain bisulphite of lime, or some other antiseptic; and if it did, it would be unfair to insist on a statement of the fact that beer contained malt adjuncts, though they had all disappeared in the process, and not to insist also on the statement with regard to the bisulphite, though it also had disappeared. He agreed that a definition of pure beer was very much wanted, but it was a fact that more bad beer was produced from bad water or bad material than from any malt adjuncts or hop substitutes which might be employed. He had seen cases of water totally unfit for brewing purposes, but a brewer might brew with sewage water for anything in Mr. Quilter's Bill to prevent him. He had had cases under his notice in which the organic matter in the water was so high as almost to constitute it sewage, and on submitting it to plate cultivation, the number of organisms developed were sufficient to cause a fever in anyone who drank it. That was the kind of thing which should be prevented. It was as bad to use bad malt or bad water as bad sugar or bad malt adjuncts. There was only one thing to be said—that the brewer had a choice of malt adjuncts, and there was plenty of competition; but he often had no choice as regards his water supply.

Mr. LOVIBOND remarked that some years ago it was found in a brewery on the Trent, that the water used contained 70 to 80 grains of Glauber salts to the gallon.

Mr. SALAMON said that coincided with his experience in some cases, though fortunately not in many.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Salamon, which was carried unanimously.

Correspondence.

APLANATISM IN PHOTOGRAPHIC LENSES.

In my remarks on Mr. Taylor's paper on "Photographic Lenses," which he read at the Society on the 26th January, after criticising what I considered his extraordinary misapplication of the term "aplanatism" in using it as equivalent to "angular aperture," I said I did not attribute the origination of that idea to Mr. Taylor, because it had been more or less used (in that sense) in popular treatises on photographic lenses, and even in Monckhoven's work on "Photographic Optics."

In justice to the late Dr. Van Monckhoven, I must ask you to allow me to withdraw that statement so far as he was concerned, for on referring to his work again—which had not been in my hands since 1867, the date of the English edition—I find he used the term "aplanatism," in its relation to photographic lenses, as Coddington and Herschel had employed it, namely, as signifying freedom from spherical aberration.

It appears to me, then, that the withdrawal of Monckhoven's authority in support of Mr. Taylor's erroneous definition of aplanatism, leaves the responsibility for the adoption of the error far heavier on Mr. Taylor.

On reference to my correspondence with the late M. Prazmowski, of Paris, I find the photographic portrait lens he made for me—in which he got rid of

the usual separation of the flint and crown in the back combination by using flint glass in the whole construction—was made in 1868-9, and not merely "about ten years ago;" my showing the lens to the late Mr. J. H. Dallmeyer would hence have been about 1869, and not merely "ten years ago."

J. MAYALL, Jun.

224, Regent-street, W.,
4th February, 1887.

SEWAGE IRRIGATION.

I was disappointed at hearing that the discussion on Dr. Carpenter's paper was concluded last night, as I had hoped for the opportunity of saying a few words upon it. I am able cordially to support Dr. Carpenter in the main object of his paper, namely, the encouragement of sewage irrigation. I fear, however, that the circumstances under which so good a result as 5s. per head of the population is possible are very rare. But irrigation would be by far the most economical, as well as the best means of cleaning sewage, even though the return were only as many pence. For it is the only process which can, under any circumstances, result in anything but loss. I agree with Dr. Carpenter that there are but few towns where irrigation is not the best means of dealing with the sewage, but the prejudice existing against the establishment of sewage farms renders it, in many cases, impossible to obtain the necessary land. I believe that the best way of removing this prejudice is to encourage the professional farmer to use sewage on his own land, at his own option, and for his own profit.

There are in many parts of the country such cases, particulars of which I have collected; and the farmer's outlay is very small, for, as Dr. Carpenter says, no expensive carriers are necessary, the sewage being distributed from the local authorities' conduit by means of simple spade-cut grips. I do not agree with Dr. Carpenter as to the use of sewage on meadow land. I am satisfied—and I am supported by the practice of several professional farmers—that sewage can be very advantageously so used. In conclusion, I beg to congratulate Dr. Carpenter on the production of a very valuable paper, at a very opportune time.

R. W. PEREGRINE BIRCH.

2, Westminster-chambers, Victoria-street, S.W.,
London, February 3rd, 1887.

Mr. W. BOTLY writes to express his concurrence with the views expressed by Dr. Carpenter as to the method of utilising town sewage, and to say that his previous opinion on the subject has been confirmed by recent visits to the sewage farms at Aldershot and Leamington.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 16.—"Uses, Objects, and Methods of Technical Education in Elementary Schools." By HENRY H. CUNYNGHAME. HERBERT C. SAUNDERS, Q.C., will preside.

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART. W. ANDERSON, M.Inst.C.E., will preside.

MARCH 2.—"The Cultivation of Tobacco in England." By E. J. BEALE.

MARCH 9.—"Railway Brakes." By WILLIAM P. MARSHALL. Sir FREDERICK BRAMWELL, F.R.S., will preside.

MARCH 15.—"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

FEBRUARY 25.—"New Markets and Extension of Railways in India and Burmah." By HOLT S. HALLETT, F.R.G.S. J. M. MACLEAN, M.P., will preside.

MARCH 4.—"Our Trade Routes to the East." By MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B.

MARCH 25.—"Indian Coffee." By FREDERICK CLIFFORD.

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

MAY 27.—"Indian Tea." By Dr. T. BERRY WHITE. H. S. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 15.—"Some of our Colonial Woods." By ALLAN RANSOME. W. T. THISELTON DYER, F.R.S., Director of the Royal Gardens, Kew, will preside.

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

The dates for the following Papers are not yet fixed:—

"Fiji." By JAMES MASON, C.M.G.

"The West Indies." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

"Australian Wines." By RICHARD BANNISTER.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 22.—"Wrought Ironwork." By J. STARKIE GARDNER, F.G.S. EDWARD J. POYNTER, R.A., will preside.

MARCH 15.—"The Application of Gems to the Art of the Goldsmith." By ALFRED PHILLIPS.

April 26.—"Ornamental Glass." By J. Hungerford Pollen.

May 10.—

May 24.—"The Importance of the Applied Arts and their Relation to Common Life." By Walter Crane.

These dates are liable to alteration.

Cantor Lectures.

The Third Course will be on "Building Materials." By W. Y. Dent, F.C.S., F.I.C. Four Lectures.

Lecture I.—February 14.—The nature of the influences to which stone is liable to be exposed as affecting its durability.—The rusting of iron, and the means adopted for preventing it.—Description of the various kinds of granite and sandstones employed for constructive purposes.

Lecture II.—February 21.—Description of the various limestones used as building stones.—Methods of testing the quality of stone.—The preservation of stone.—Artificial stone.—Terra cotta.—Firebricks.

Lecture III.—February 28.—Lime.—Kilns used in the calcination of limestone.—Mortar.—Cements.—Manufacture of Portland cement.—Utilisation of blast-furnace slag.—Plaster of Paris.

Lecture IV.—March 7.—Asphalt described.—Timber: causes which promote its decay.—Methods adopted for its preservation.—Description of the creosoting process.—Painting.

The Fourth Course will be on "Testing Materials of Construction, especially Iron and Steel." By Prof. W. C. Unwin, F.R.S Three Lectures.

March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Structure of Textile Fibres." By Dr. Frederic H. Bowman, F.L.S., F.G.S Five Lectures.

April 25; May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Y. Dent, "Building Materials."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Adjourned discussion on Mr H. J. Mackinder's paper, "The Scope and Methods of Geography."

British Architects, 9, Conduit-street, W., 8 p.m. Professor T. Hayter Lewis, "Notes made during Tours in Greece, 1881 and 1884."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury circus, E.C., 5 p.m. Mr. W. B. Richmond, "The Future for Art."

Tuesday, Feb. 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Allan Ransome, "Some of our Colonial Woods."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture V.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Further discussion on Mr. William Joseph Dibdin's paper, "Sewage-Sludge and its Disposal," and on Mr. William Santo Crimp's paper, "Filter-Presses for the Treatment of Sewage-Sludge." 2. Mr. William Willcocks, "Irrigation in Lower Egypt."

Statistical, School of Mines Jermyn-street, S.W., 7¾ p.m. Major P. G. Craigie, "The Size and Distribution of Agricultural Holdings in England and Abroad."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, Feb. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Henry H. Cunynghame, "Uses, Objects, and Methods of Technical Education in Elementary Schools."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Discussion on the Hon. R. Abercromby's paper on "The Identity of Cloud Forms all over the World, and on the General Principles by which their Indications must be read." 2. Dr. H. H. Hildebrandsson, "Remarks concerning the Nomenclature of Clouds for ordinary use." 3. Hon. Ralph Abercromby, "Suggestions for an International Nomenclature of Clouds." 4. Dr. W. Marcet and Mr. A. Landriset, "The Influence of Weather on the proportion of Carbonic Acid in the Air of Plains and Mountains."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. D. Gravell, "Reservoir Dams."

Thursday, Feb. 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Sir John Lubbock, "Phytobiological Observations (Part II.), viz., Forms of Seedings and Leaf of *Lirivdendron*." 2. Mr. P. C. Hock, "*Dichclaspis pellucida* from Scabs of Hydrophid." 3. Mr George King, "Observations on the Genus *Ficus*."

Chemical, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. S. Thompson, "Electric Bells." (Lecture II.)

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. Rogers, "The History of Wood Carving."

Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W., 5 p.m. Mr. Charles E. Cassal, "Food Adulteration and Analysis."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. W. Rücker, "Molecular Forces." (Lecture V.)

Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Friday, Feb. 18...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. W. Crookes, "The Genesis of Elements."

Philological, University College, W.C., 8 p.m. Paper by Mr. H. Bradley.

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. George A. Becks, "Diving; the Apparatus used, and the Work carried out under Water."

Geological, Burlington-house, W., 1 p.m. Annual Meeting.

Saturday, Feb. 19...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "Modern Composers of Classical Song—Jensen, Lassen, Holstein, Berlioz, and Wagner" (with Vocal Illustrations). (Lecture V.)

Journal of the Society of Arts.

No. 1,787. Vol. XXXV.

FRIDAY, FEBRUARY 18, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for prime motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows :—

The motors will be divided into two classes, (A) and (B). One gold and two silver medals will be awarded in each class; and two gold medals will be awarded at the discretion of the Committee, if, in their opinion, the merits of the motors submitted in competition render such an award desirable.

(A.) Motors in which the Working Agent is also Produced.

Steam.—Ordinary portable or semi-portable non-condensing engines.

Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer.

Petroleum vapour.

Liquid petroleum.

(B.) Motors to which the Working Agent must be Supplied.

Steam.—Detached engines, non-condensing, without boilers.

Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas.

Hydraulic.—Water motors.

Each class will be subdivided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p. No motor will be worked at a greater power than that at which it is entered.

For four-horse power and under, the entrance fee will be £10; above four-horse power, the entrance fee will be £2 10s. per h.p. The fees to be paid on entry.

The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

The Council will publish the awards in the *Journal* of the Society of Arts. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

Attention is hereby directed to this date, after which no entries for this competition can be received.

CANTOR LECTURES.

Mr. W. Y. Dent, F.C.S., F.I.C., delivered the first lecture of his course on "Building Materials," on Monday evening, 14th inst., in which he described the various kinds of granites and sandstones employed for constructive purposes.

The lectures will be printed in the *Journal* during the summer recess.

EXAMINATIONS.

Mr. Thomas A. Reed has been appointed Examiner in Shorthand, in place of Mr. Frederick Pitman, deceased.

THE JOURNAL.

The Secretary will be greatly obliged if the members of the Society will inform him at once of any irregularity which may occur in the delivery of the *Journal*.

HER MAJESTY'S JUBILEE.

The Council have much satisfaction in acknowledging the very liberal response which has been made to their appeal for contributions to a Special Society of Arts Fund for the Imperial Institute.

They hope that they may still reckon on donations from many members who have not as yet subscribed.

Subscriptions of small as well as large amount will be gratefully received. It is hoped that not only may the sum subscribed be considerable (as it already is), but that the list may include a large proportion of the names of the members.

	£	s.	d
Charles Denton Abel	20	0	0
Sir Frederick Abel, C.B., D.C.L., F.R.S., Vice-President	50	0	0
William Anderson, Member of Council	50	0	0
Sir William Andrew, C.I.E.	20	0	0
The Attorney-General, M.P., Member of Council	30	0	0
Henry McLauchlan Backler, F.R.G.S.	10	10	0
W. J. S. Barber-Starkey	5	0	0
Edward Beanes	5	0	0
Sir Francis Dillon Bell, K.C.M.G., C.B., Member of Council	30	0	0
George Blagden	2	0	0
John Bloomer	5	5	0
Francis Botting	0	10	6
W. P. Branson, F.R.G.S.	5	0	0
Edward M. Browell	5	5	0
Eric Stuart Bruce, M.A.	1	1	0
S. M. Burroughs (Messrs. Burroughs, Welcome & Co.)	5	0	0
Alfred Carpmael, Vice-President	20	0	0
Arthur Cates	10	10	0
Edwin Chadwick, C.B., Vice-President	10	0	0
Charles Cheston, M.A., Member of Council	20	0	0
B. Francis Cobb, Treasurer	10	0	0
Henry L. Cohen	5	0	0
Sir Daniel Cooper, Bart., K.C.M.G.	100	0	0
T. R. Crampton, Vice-President	30	0	0
Colonel A. Angus Croll, J.P.	5	5	0
Sir Juland Danvers, K.C.S.I., Member of Council	10	0	0
Professor James Dewar, M.A., F.R.S., Vice-President	10	0	0
F. W. Docker	5	5	0
Henry Doulton, Member of Council	100	0	0
D. J. Russell Duncan	5	0	0
W. Dashwood Fane	5	0	0
Robert Galbraith, jun.	2	0	0
Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of Council	50	0	0
Carlo Giuliano	10	0	0
Carried forward	£652	11	6

	£	s.	d.
Brought forward	£652	11	6
George Godwin, F.R.S.	30	0	0
Colonel William Gray	10	10	0
Andrew Greig, C.E.	1	1	0
Acton F. Griffith	1	1	0
Colonel R. Harrison, C.B., C.M.G.	2	2	0
William Henry Haynes	0	10	6
Frederic Hill	3	0	0
E. R. Holland	3	3	0
J. Satchell Hopkins	10	0	0
Henry Horne	5	0	0
J. Bennett Howell	5	0	0
Professor D. E. Hughes, F.R.S.	5	0	0
Charles W. Jackson	1	1	0
Col. Robert Raynsford Jackson	10	0	0
Henry Joachim	2	2	0
J. Henry Johnson	5	0	0
Rev. W. Taylor Jones	1	1	0
E. T. Kensington	3	3	0
Henry Kent	5	0	0
Edward A. H. Kraftmeier	10	10	0
Edwin Lawrence, LL.B., B.A.	100	0	0
Alfred Le Grand	1	1	0
Major-Gen. J. F. Lester	1	1	0
James Leverson	2	2	0
Mrs. McGarel	5	0	0
George Matthey, F.R.S., Vice-President	30	0	0
Messrs. Meyer and Mortimer	105	0	0
E. Chambers Nicholson	100	0	0
Colonel Chas. H. Page, J.P.	1	1	0
Mrs. Paine	2	0	0
James Paxman (Messrs. Davey, Paxman, and Co.)	100	0	0
W. H. Preece, F.R.S., Vice-President	10	0	0
Sir Robert Rawlinson, C.B., Vice-President	20	0	0
Henry D. Rhodes	1	1	0
Benjamin Richardson	2	0	0
H. Cameron Richardson	1	1	0
Owen Roberts, M.A., F.S.A., Vice-President	30	0	0
E. C. Robins	5	0	0
Rev. Henry Ross, M.A.	1	1	0
Sir Arthur Rugge-Price, Bart.	20	0	0
"W. R. S."	5	0	0
Sir Saul Samuel, K.C.M.G., C.B., Member of Council	30	0	0
James Solly	2	2	0
John Thompson	10	0	0
John I. Thornycroft	50	0	0
Alfred Savill Tomkins	1	1	0
Rev. J. P. Tomlinson	5	0	0
Philip F. Walker	10	10	0
H. Barlow Webb	10	10	0
William Westgarth	100	0	0
J. H. Whadcoat, F.S.S., F.C.A.	2	2	0
W. C. Wheatley	1	1	0
R. R. Whitehead, M.A., J.P.	5	0	0
Carried forward	£1,536	10	0

	£	s.	d.
Brought forward	£1,536	10	0
Peter Williams	5	5	0
Thomas W. Wing	50	0	0
Alfred Wise	3	0	0
James T. Wood, M.A.	10	0	0
Henry Edward Wright	10	10	0
John Yeats, LL.D.	5	0	0
Total	£1,620	5	0

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

COLONIAL AND INDIAN EXHIBITION REPORTS.

The Reports on the Colonial Sections of the Exhibition, prepared under the direction of the Council of the Society, at the request of his Royal Highness the Prince of Wales, Executive President of the Exhibition, and President of the Society, will shortly be issued. The volume will contain the following reports :—

1. Mining Industries. By Dr. C. Le Neve Foster.
2. Minerals, Gems, &c. By J. Reynolds Gregory.
3. Meat. By Clare Sewell Read.
4. Grain. By W. Procter Baker.
5. Fruits. By D. Morris.
6. Tea. By A. G. Stanton.
7. Coffee. By H. Pasteur.
8. Cocoa. By H. Pasteur.
9. Sugar. By Neville Lubbock.
10. Wines, Beers, Spirits, &c. By R. Bannister.
11. Tobacco. Dr. G. Watt and J. Macarthy.
12. Drugs, Chemical and Pharmaceutical Products. By Dr. B. H. Paul.
13. Oils and Fats, &c. By Leopold Field.
14. Gums and Resins, &c. By T. Bolas.
15. Cotton. By J. Butterworth.
16. Wool. By Dr. F. H. Bowman.
17. Silk. By T. Wardle.
18. Miscellaneous Fibres. By C. F. Cross.
19. Leather, Skins, and Furs. By J. Powell.
20. Timber (Part I.). By T. Laslett.
21. Timber (Part II.). By Allen Ransome.
22. Machinery. By W. Anderson.
23. Musical Instruments. By Dr. Stainer.

Passages, stated to be extracts from certain of these reports, have been published by a weekly newspaper. These seem to have been taken from uncorrected proofs obtained by this paper, and without the consent of the authors or the sanction of the Council.

The work will be published by Messrs. Clowes.

Proceedings of the Society.

INDIAN SECTION.

Friday, February 11, 1887; SIR GEORGE BIRDWOOD, M.D., LL.D., C.S.I., in the chair.

The CHAIRMAN, in introducing Dr. Watt, said he was an officer of the Educational Department of the Government of India, having since 1873 been Professor of Botany in the Calcutta University. For some years past he had been attached as Scientific Officer to the Government of India in the Department of Revenue and Agriculture, and had recently become well known in this country as one of the Commissioners for the Government of India in special charge of the Indian Economic Section of the late Colonial and Indian Exhibition. He was, therefore, most competent to deal with the subject of the paper he had been asked to read that evening before the Society.

The paper read was—

THE ECONOMIC RESOURCES OF INDIA.

By DR. GEORGE WATT, C.I.E.

INTRODUCTION.

When invited by the Council of the Society of Arts to read a paper before its Indian Section, I was a little troubled as to what subject might prove the most attractive. Some short time ago, however, I had the honour to read a paper before the Royal Colonial Institute on "The Trade of India and its Future Development," and it occurred to me that the general lines of the Indian trade therein briefly indicated might be followed up advantageously by my choosing for the subject of this evening's discussion "The Economic Resources of India." The term "economic" I use as conveying a wide and comprehensive conception, for I include products which are valuable and utilised as well as products which, while they possess intrinsic merit, are not, or only to a limited extent, employed by man. At the same time, as far as it is possible to isolate the study of raw products from industries, I exclude manufactures or industrial productions. The expression "economic products" is one of those convenient appellations which few people stop to inquire into the precise meaning of; but I take it that a natural product, the moment it comes to be examined as

of possible use to man, is then, in the usual acceptation of the term, admissible as an economic product.

Adopting this meaning of the term, I shall endeavour to direct your attention to existing trade products, the properties and uses of which are fully understood; but in doing so I shall limit myself to such as give indications of a more extended future. At the same time I shall dwell with even more urgency on the intrinsically valuable products of India which, at the present day, are employed by the natives of India only, or are not used by man at all, although possessing properties which seem likely to make them articles of European trade in a not very distant future. But I hope all the while to be able to keep ever before me as a duty to indicate the share which India seems likely to take in the development of her economic resources, even should this lead me into prophecies which, to the British manufacturer, may be gloomy forecasts of India's future as a great producing country of steam power manufactured goods.

My apology for imposing on the members of the Society of Arts so serious a discussion, is the ignorance which has for so many years prevailed on every Indian question, and the growing importance, in recent times, of any subject connected with our eastern dependency. Let it be not forgotten that that vast empire has given to her Most Gracious Majesty the Queen of England the exalted title of Empress of India, and has placed in her hands the sceptre of the power which now rules the destinies of kingdoms and principalities inhabited by races as distinct from each other and as numerous as are the various nationalities of Europe. Just as no Indian administrative question can be rightly understood by a person who possesses only a book knowledge of the magnitude of India, and of the intricacies of obligations and interests which so constantly conflict with social and religious prejudices, so no Indian commercial subject can be correctly studied without a personal acquaintance with India and its people. It is the want of this knowledge that has caused English goods to lag in the markets of India when brought into competition with German, American, and French manufactures. The English manufacturer, slow and stubborn to change his machinery, and thus to adapt his manufactures to the wants and necessities of the people, has in many departments of Indian trade been distanced by his more astute competitors. In a like manner ignorance of the multiplicity of climates and soils which prevail in India has prevented the introduction and cultivation of many products required by Europe, which the rich alluvial expanses of India can, and do to a small extent, produce more cheaply than can be done in any other part of Her Majesty's dominions. This twofold ignorance is happily being dispelled; but while India will in the future more completely reciprocate her trade with England, a new element will, day by day and year by year, make itself felt, for the heavy tread of the steam-engine is carrying into the utmost corners of India the power to manufacture her own raw products to meet the demands of her own people. The great future to India of her commerce hinges on the extension of this home trade, and the compensation to England for the loss which will thereby accrue, rests in the adoption and utilisation of the new commercial products which India can furnish to England. I shall, doubtless, fail to give you an adequate outline of the economic resources of India, but I shall fail because my subject is so gigantic that its ramifications extend into every known industry. To touch on the more important topics would mean to write a volume, which could not be analysed even during the short period allowed for this evening's meeting.

The Imperfectly Known, or Minor Products of India.

There are food grains that loudly call for more thorough investigation and more extended cultivation. Dyes, tans, and fibres, which betoken fortunes to the industrious persons who will carry to a practical issue the initial experiments necessary to successful introduction. There are minerals and ores in sufficient abundance to admit of profitable competition with the supplies poured in from foreign countries. But above all, there are the thousand and one little insignificant things lying at our feet which, in the hands of the technical expert, will each come to meet a distinct market. To Government, these unimportant industries offer naturally a great attraction, for, without capital and without expensive plant, the poorer natives can participate in the trade done in them. But it would be hopeless to attempt to enumerate, even by name, the multitude of natural or wild products in which trade might be done. Seeds which will yet have a commercial value as ornaments and buttons. Fibres which are likely to be

used as useful and cheap substitutes for whalebone and bristles. Palm spathes, which may come into use as natural surgical splints, or be employed as simple mechanical filters. The fibrovascular frameworks of cucurbitaceous fruits, which constitute admirable bath-room sponges. Small pieces of *solah* pith to displace patent corn-plasters, or to be used in place of wax in the preparation of microscopic sections. The employment of pith instead of cork for many purposes, such as for floats to fishing nets. Fungi and pith utilised as substitutes for felt in the manufacture of at least certain parts of hats. The indefinite series of uses to which the bamboo is put in all Asiatic countries, but of which Europe is ignorant. Indeed, the application of the bamboo to European wants seems so natural, that it is impossible to avoid the surprise that in an age of keen competition for novelties, this has not been done long ago. The bamboo is eminently suitable for many details in household fittings. The thicker joints make quaint umbrella stands; the better qualities are so hard that they are used by the natives of India as swords and knives, and these would make admirable and clean paper knives, cheese and butter knives, and, cut up into smaller pieces, might, with great advantage, be employed as pegs by cabinet-makers and shoe-makers. The gums and resins, which have each their peculiar properties—properties far better known to the simple and primitive aboriginal inhabitants of the wild forest tracts than to the professional experts of Europe, who often value samples according to a crude standpoint, viz., the colour, appearance, and condition of package demanded by the trade. This standpoint is conservative to established brands, but precludes the possibility of the properties of new products being investigated. The practice of the simple *Santal* in mending his iron cooking pot by means of the *sal* resin (the resin of *Shorea robusta*) suggests a use for that, at present, valueless substance, as it indicates also a personal acquaintance with its properties. It is not at all improbable that the properties of this and many other little-known gums and resins will commend themselves in the future to persons who may be in search of substances with properties we have not as yet been educated to require. The useless hog-gum (the gum of *Cochlospermum Gossypium*), consigned falsely as tragacanth, has been accidentally discovered by the bookbinder to be invaluable for marbling purposes, and the gum of *Sterculia urens* has been found to restore to tasar silk the lustre removed from it during an improved process of reeling that fibre. Practically, the one requirement for gum in Europe is a strong and useful adhesive mucilage, and although, with care in selection and packing, India might easily come to play a much more important part in this trade than it has done in the past, India has, at the same time, gums and resins which possess distinctive properties, each one of which finds in India a market in meeting the demands of some indigenous industry. But I have said enough to indicate the long category of the unimportant products of India. The bulk of these products are, however, unimportant only in a European sense. The people of India are indeed children of nature; they are perhaps far more dependent upon nature than any other community in the same condition of civilisation. Natural or wild products not only form the bulk of their ornaments and their children's toys, but there are few people in India who are not dependent, to a large extent, for food on the plants climbing the village hedgerows, or floating over the tanks which their ancestors excavated. They are herbalists, and their medicinal plants are all gathered from the neighbouring jungles. To the people of India, therefore, the products I have, from a comparison with the trade done in the staples of India's foreign commerce, designated as unimportant, are by no means so. The diffusion of definite and accurate information regarding these substances will, in some instances, extend their use from one province to another, and in others create a foreign demand for them. Indeed, so important are these minor products to the people of India, that they may be said to give the finishing touches to the story of India's productive resources. They not only enter into the everyday domestic life of the people, but, in many instances, give that charm to the handicrafts of India which western skill has vainly tried to imitate. Given the raw product which imparts the actual tinctorial principle, and the European dyer fails to produce the desired result because he has overlooked the laborious and apparently meaningless combinations which centuries have taught the Indian dyer to employ. The use of soap in washing the fabric in one case, and the employment of saponaceous nuts for that purpose in another, have as much to do with the beautiful and permanent colours produced as have the complex series of vegetable and mineral mordants.

THE IMPROVEMENT OF THE INTERNAL AND FOREIGN TRADE IN THE MINOR PRODUCTS OF INDIA.

What India most loudly calls for is more technical knowledge, both on the part of her artisans and on the part of Government officials who are responsible for the instruction, or what is more nearly correct, for the neglect of these artisans. If the products employed by the labouring classes of India are ever to become articles of European commerce, if the patient workmen who use these substances are to be assisted in the great struggle for existence which western civilisation has brought upon them, then technical education among the working classes must drain away a large portion of the public money which has hitherto been spent in affording University instruction at a nominal rate to the wealthy. A combined effort must be put forth not to spend money in supposed improvements in the agricultural systems of India, or in too hasty revolutionary changes in the practices of the artisans, but for ourselves more thoroughly to master a knowledge of those time-honoured systems which have produced the results which are to this day the admiration of the world. But there is not a moment to waste, for the catch-penny productions of Germany, and the barbarously-coloured handkerchiefs of England are rapidly driving the hand-loom and the weaver out of existence, just as the cheap aniline dyes are closing one-half the dyers' shops of India. India requires the technical knowledge of Europe to be placed at the disposal of her artisans, but only in such a way that they may be enabled to draw from it bit by bit, as they require assistance. Technical knowledge is also essentially necessary to any great improvement in the internal and foreign trade of the country. There can be little doubt that were it possible to convey to India a tenth part of the earnest inquirers who appear at even one exhibition, and to leave them for a twelvemonth to roam over India, more lasting good would be accomplished than by participation at a hundred international bazaars. The samples usually exhibited at these shows are too small for any practical results being arrived at, and the information with which they are accompanied is too meagre. The busy manufacturer returns from the exhibition to the din of his looms disappointed and disheartened, for not only are the samples too small to admit of their being practically tested, but they are carefully picked and prepared specimens, and in no way correspond to trade samples. They are misleading, and serve but one good purpose; in isolated cases they may tempt the manufacturer to pay a visit to India in order to ascertain there what the exhibition failed to teach him. It is by no means easy to see how these dangers can be averted, for the element of competition is the ruin of all practical results from exhibitions. Speaking for India, far more good would come to the country were the money usually devoted to exhibitions to be spent in fostering and developing the internal trade, and in obtaining definite information as to what actually exists in India, and how and for what purpose each product is employed by the natives.

Although very praiseworthy efforts have been made by the Government to arrive at some tangible knowledge of the internal trade of India, as compared with our knowledge of the foreign trade we are grossly ignorant. It is this ignorance which, to a large extent, precludes us from being able to come to the aid of the thousands of hand labourers who are being driven out of employment through competition with steam. It is our want of technical knowledge that stands in the way of our extending a helping hand to the patient artisans of India. How and in what way they can be helped to establish steam factories and calico-printing works it may be difficult to see, but by this means alone can they hope to compete in the future with the cheap productions of advanced mechanism. It is pure sentiment to believe that any protective system, or that any amount of sympathetic encouragement, could bolster up hand labour against the gigantic improvements in production which are each day coming into the field of competition. I maintain that the popular idea that anything can be done with cheap labour, or indeed that India does possess cheap artisan labour, is as mistaken and false as the equally common notion that the rivers annually inundate and manure the fields of India. There is probably no more misleading conception than the popular idea of the cheap labour which India possesses. Certain agricultural classes do indeed labour on small wages, or no wages at all, but the artisan classes receive high wages, and when it is recollected that the corresponding workman will in England do as much as any two or three Indian artisans, skilled labour then appears in its true light. An ordinary mason, carpenter, or blacksmith, received in the three great presidencies of India the following monthly wages during the year 1884:—

	Average.		Maximum.
Madras	Rs. 14	....	Rs. 18
Bombay	Rs. 28	....	Rs. 45
Bengal	Rs. 9	....	Rs. 20

Taking the lowest view of one English artisan doing the work of two Indians, we arrive at the price of skilled labour—in Madras, £32; in Bombay, £66; and in Bengal, £20 per annum. This, however, is a remarkably low estimate, for most mill owners in India would place the value of native as compared to English labour as nearer three to one, while the difficulty of housing and managing three times the number of hands still further increases the price of Indian skilled labour. It is a remarkable fact, however, that it is the agricultural class who have taken most readily to work in our factories, but they are no sooner educated to their duties than they demand wages quite as high as, and in some cases higher than, the artisans are earning outside the factory. This consideration of the wages of artisans is of vital importance, for the contention I desire you to consider is, that, sooner or later, the competition of steam against hand labour will gain the day. It becomes, therefore, our duty to accept this position, and to strain every nerve that steam may not force European requirements and European ideas too far, but that native ideas and native patterns and designs may be worked on the power loom with as much adherence to the original as possible. I am aware that my words are opposed to the desirable conservation of native art, but however much I may regret that, in the remarkable commercial advances India is making, the India of the future will bear little resemblance to the classical India of the past, change is inevitable, and of the two evils—European imported goods or Indian made goods by European principles and machinery—it is preferable that India should open out her own factories. She will then at least have the chance of producing the articles most suited to her people, and in so doing she will become prosperous and more self-supporting.

The Peculiarities of India as an Agricultural Country.

India is essentially an agricultural country; the development of its economic resources must to a large extent mean the improvement and extension of its trade in the annual crops removed from its vast alluvial plains. If to this we add the somewhat scanty supply which India possesses of minerals and ores, and the unimportant and wild forest products which we have already discussed, we shall have produced a brief statement of the economic resources of the empire. The prosperity of Great Britain centres around her remarkable wealth of minerals and ores, far more than her rich agricultural fields and industrious farmers. Coal and iron, through steam power, have advanced England into her proud position as the greatest manufacturing nation in the world. Forced by adverse competition with the more productive industries, cultivation has in England given place to sheep farming and cattle rearing, but it is doubtful how far even this will, in the future, prove remunerative. It is quite otherwise with India. Coal and iron occur in many isolated regions, but the vast intervening expanses of rich agricultural lands are infinitely more valuable; and so much is this the case, that the wealth of India may, with a degree of assurance, be pronounced her agricultural produce, just as the weakness of India may be said to be her indebtedness to other countries to work up and utilise her raw products.

The total area of India has been determined as 1,382,624 square miles, and the population as 253,891,821. Although immense tracts of country are annually cultivated, according to the most recent survey, 100,000,000 acres of land suitable for cultivation have not, as yet, been ploughed. At the same time, 120,000,000 acres are returned as waste lands. There is thus plenty scope for a greatly increased cultivation, and should the demand continue for India's agricultural produce, there can be little doubt but that this can be met without narrowing the space required for the foodstuffs of the people.

In my lecture at the Royal Colonial Institute, I endeavoured to show that the wheat export trade of India was a perfectly natural and sound one, and that there was every chance of its extending still further. Wheat has not displaced the crops formerly grown as food for the people of the soil, since at the same time that wheat has developed into an important article of trade, the oil seeds have increased 78½ per cent. in quantity, and 69½ per cent. in value. This remarkable fact can alone be accounted for by a greatly increased cultivation. But when it is recollected that this increased cultivation of oil seeds was coincident with the growth of the wheat trade, it becomes evident that immense tracts of land which formerly lay waste must have been thrown under cultivation. Everything points

to the possibility that, with increased demand, the ploughman will leave the crowded centres into which the Indian people are grouped and spread into the unpeopled tracts, until the 100,000,000 acres of rich uncultivated land become gradually diminished. There is, perhaps, no problem that has troubled the Government more than the prejudices of the people to leave their villages and take up new lands. A solution of this difficulty is doubtless, however, not far distant, for the remunerative export produce trade will tempt them to the regions where money can be most readily obtained, the more so since the prosperity of certain communities will increase the prices to others less fortunate. Where lucrative employment may fail to tempt, comparative poverty will force migration from one part of the country to another. In this way poverty and privation from overcrowding will be mitigated, and the people of India grow richer as their country is made more productive. Perhaps one of the most conclusive proofs of the advantage to India from the wheat trade is to be had in the fact that, while the value of the exports of wheat were last year over £8,000,000 sterling, the prices of other food stuffs and of wheat itself have, if anything, grown cheaper during the past twenty years. As a positive indication of increasing wealth, India is steadily swallowing up large quantities of gold and silver. During the past five years £60,000,000 worth of gold and silver were required by India, and little short of 350 millions' worth have disappeared during the past fifty years. If a still further proof be necessary that agricultural progression may fairly be accepted as a sure indication of increasing wealth, it may be had in the fact that the people of India now hold over £20,000,000 sterling of their country's debt. Year by year they are also showing a greater zeal in purchasing shares in railways and other public companies, instead of hoarding their gold and silver as in former years.

The Important or European Commercial Products of India.

I shall now endeavour to draw your attention to a few of the important commercial products of India, but in so doing I shall try to keep clearly in view two considerations :—

(*a.*) Products the European trade in which is capable of greater extension.

(*b.*) Products practically unknown to European commerce, but which promise to become of very considerable importance.

For convenience we shall examine certain products in the order of the following classes, taking under each class, first, those which are well known to commerce, and, second, those which may be called new commercial products :—

Class 1—Food substances.
Class 2—Narcotics and drugs.
Class 3—Fibres ; and
Class 4—Oils and oil seeds.

I.—Food Substances.

The principal food substances exported from India are rice, wheat, pulses, and millets.

Rice.—Very little need be said regarding the rice trade of India. There are annually about 60,000,000 acres under that cereal, of which more than half are in Bengal. The bulk of the exports are, however, from Lower Burma, where out of 4,000,000 acres of cultivated lands, 3,000,000 acres are annually under rice, and that too almost expressly to meet the export trade. Last year the exports of rice were valued at over £9,000,000 sterling, and that large amount paid an export duty of nearly 15 per cent. Rice and opium are the only articles which are made to bear an export duty. It is probable that the rice trade of India will not increase much beyond its present position, and it is doubtful if the removal of the duty would reduce it to such a price as to commend it as a general article of food to the working classes of Europe.

Wheat.—The wheat trade has increased in a perfectly unprecedented manner, and it shows by no means any indication of having reached its highest point. It occupies a perfectly distinct place in the European market, being highly suitable for the purposes of the macaroni trade, but too dry and ricey to be used exclusively by the baker. A loaf made of it would never keep together, but a certain proportion of Indian wheat mixed with other qualities is much admired. This peculiarity of Indian wheat is common to the wheats of all warm countries, and is, doubtless, due to the fact of the grain maturing with the approaching heat of summer instead of with the cold of winter.

The greatest obstacle to an extended trade in Indian wheat is the impure state of the grain. If not loaded with dirt, it is at least immensely depreciated through admixture with coarse barley, and one or two pulses, chiefly the objectionable seeds of *Lathyrus sativus*. These adulterants are not, it is believed, purposely added to the grain, but, through care-

less cultivation, they are allowed to spring up with the wheat instead of being weeded out. Were it possible to induce the cultivators to use more carefully collected seed, these weeds would soon disappear, but one or two plants growing in the wheat field will often greatly depreciate the value of the produce of an acre. It is perfectly appalling to compare the heavy dirt-laden grain from India with the clean wheats from Europe, America, and Australia. Efforts are being made to overcome this by having the grain cleaned and assorted at the seaboards before shipment, but it would seem desirable that this should be done near the centres of greatest cultivation, and before railway freight has been paid. The assortment near the coast removes also the chance of being able to bring together all the consignments of the same quality from a district, and hence has come into existence the insecurity in uniformity of supply. By the present system of despatching in sacks instead of in bulk, both railway and shipping charges are greatly increased. It may be doubtful how far the Government, as a great railway proprietor, could step in and lead the way to a reform of these imperfections; something must be done sooner or later, otherwise the unprecedented development of the wheat trade, from its very magnitude, will bring about its own ruin. Some half a dozen collecting centres should be organised in the interior of the country, where the grain could be collected, assorted, cleaned, and, if possible, sent in bulk to the shipping port. This might be done by the Government constructing and then renting out to merchants specially designed houses at a selected number of convenient railway stations, and by Government seeing that an important article of food like wheat was not retarded at the junctions of different railway companies. It is by no means an unusual thing in India to see thousands of sacks of wheat stacked on an open platform, with, as their sole protection, a waterproof sheeting thrown over them. These great accumulations of wheat have to take their chance of weather while awaiting the convenience of the railway companies to convey them to the seaboard. Treatment of this kind is certain to damage the grain, and will, sooner or later, greatly injure the prospects of the Indian wheat trade. By cleaning the wheat as near the source of supply as possible, heavy railway charges would be diminished, and it is these charges which, in times of abundant harvests in Europe and America, narrow dangerously the margin for profit. No greater calamity to a large and ever increasing community in India could possibly happen now-a-days, than a sudden stoppage of the demand for wheat. Such a calamity could, of course, be best averted by the people being induced to produce purer and cleaner wheat. Local centres for collecting, carefully housing, cleaning, assorting, and despatching in bulk, according to the most improved American methods, would go a long way towards redeeming the Indian wheat from the injury done to it by a conservative people, whom it is difficult to induce to improve even where improvement would be to their own advantage. The poverty of the Indian cultivator, the smallness of the individual supply, and the multiplicity and isolation of the persons concerned in swelling the now immense annual production, are the great obstacles to reform and improvement.

Oats.—Perhaps few people in England are aware of the fact that India could not only cultivate oats to a very large extent, but that within the past few years a small export trade has actually been started in that cereal. There can be no doubt that India could and probably may in the future appear on the lists of the corn marts of the world as a country from which oats are obtained.

Indian-corn.—As far as I have been able to ascertain, Indian-corn is not exported from India, but if the demand for it increases much further we shall certainly hear of the quotations for Indian maize.

Pulses.—A small amount of Indian peas, beans, and pulses are regularly exported to Europe, but it would seem that the properties of one or two of the best Indian sorts are not understood, otherwise a much greater trade would be done in them. It is a common error to say that rice is the staple food of the people of India. It is the staple of perhaps 80,000,000 or 90,000,000 out of the 253,000,000 of people of India. Millets and pulses, with a little rice, wheat, or maize, as luxuries, are the food stuffs of the great bulk of the inhabitants of India. Even the rice eating people rarely eat rice alone. The muscle-forming ingredient in their diet is the pigeon-pea, or *dhal* (*Cajanus indicus*), one of the best and most nourishing of Indian pulses. This is eaten in various ways, but a sort of thick pea-soup poured over boiled rice is perhaps the most frequent preparation. The pigeon-pea is, however, by no means the best pea in India, although, from its abundance and cheapness, it is the one of which the greatest hope may be entertained for a

future export trade. The soy-bean (*Glycine Soja*) is more expensive than *dhal*, but it is much more nutritious. Indeed, it is entitled to the highest place amongst all known pulse, its nutrient value being 105, as compared to 80 to 87 for the nutrient values of peas and lentils.

At the present day both *dhal* and *soya* are only imported into this country in small quantities, being employed almost entirely in the preparation of patent foods for infants and invalids. They are, as ordinary articles of diet, brought into competition with English, American, and Egyptian peas and lentils, but it is highly probable that, were their claims for consideration only urged a little more freely, a large trade might spring up in these useful food substances. Perhaps no other Indian pulse deserves however, greater attention than the chicken-pea or *gram* (*Cicer arietinum*). Horses in India are universally, and in many instances exclusively, fed upon this seed. The allowance is soaked in water for an hour or so before being given to the horse. This has the effect of both softening the seed and freeing it from mud. About eight to ten pounds a day is considered an abundant supply along with grass or hay. A more rational diet is, however, to crush the *gram* along with about an equal quantity of corn. This diet, from a scientific point of view, ought to prove more wholesome than gram alone. It must be admitted that horses in, perhaps, no other part of the world are in better condition than the Indian gram-fed carriage horses, and sheep reared upon gram are proverbial as affording admirable mutton. Within recent years an immense trade in Indian corn has come into existence in England for the purpose of feeding horses, crushed Indian corn being mixed with oats. Chemically, a horse diet which consists exclusively of cereals cannot be so good for the animal, nor so likely to produce muscular strength, as a diet with a liberal admixture of some kind of peas. Husked gram contains of albuminoids 21·7 per cent., and of starch 59·0 per cent. Indian corn contains of albuminoids only 9·5 per cent. to 70·7 per cent. of starch. When it is recollected that the albuminoids are the muscle-forming constituents of diet, it becomes apparent that a diet which would contain oats and gram, or Indian corn and gram, would be far more nutritious and strength-giving than the modern English food for horses of oats and Indian corn. To obtain the indispensibly necessary amount of albuminoids from an English diet, the animal has to eat a greatly excessive and injurious amount of starch.

From these considerations it would appear that the food given to horses in India is a much more rational one than that which prevails in England, and it is therefore possible that a large trade may spring up in Indian gram when once these facts are brought home to the attention of persons interested in feeding large quantities of horses, such as our omnibus and tramway companies.

Fruits and Nuts.—There are so many other food substances of which one might speak of, that it is difficult to restrict one's observations to one thing more than another. The trade in *mahua* flowers (the flowers of *Bassia latifolia*) has received a sudden check from the action of the French Government. In addition to being invaluable for the purpose of feeding pigs, it was early discovered that these flowers might and were being used in distillation. Fiscal restrictions have thus injured the trade in an article which, but for this difficulty, promised to come into extensive use. Both the oil from the seeds and the sweet nutritious flowers are articles of the greatest importance to the inhabitants to the central table-land of India. The oil bids fair to come into European commerce for the candle and soap trade.

Many of the preserved fruits of India seem hopeful articles of future export trade. The sun-dried apricots of Afghanistan are particularly deserving of attention. Of the nuts, the Singara (*Trapa bispinosa*) is, perhaps, one of those novelties that one cannot help feeling surprised at its not having found its way to Europe. In Kashmir alone it is stated that 30,000 persons are dependant upon this wild aquatic plant. The pistachio-nut (the seed of *Pistachia vera*) is another equally deserving nut, which would seem likely to be run upon were it once introduced into Europe. But one might enumerate a long wearisome list of fruits, for the tamarind, the Bokhara plum, the Indian date, the edible pine, and a host of other nuts and fruits have still to be introduced into European trade. Even arrowroot, which is now manufactured all over India, has not as yet attained to a commercial position.

Class II.—Narcotics.

Under this class I wish to remind you almost by name of tea, coffee, and tobacco. Indian tea has within the past twenty years become an established article of trade between India and England. The outcry now is that tea planting has been overdone; but were the tea planters and their agents to devote only a small

amount of that energy upon India which they have spent in pushing their teas into all European countries, an immense Indian demand might be created, which would soon call for even more tea estates that at present exist. It is a scandal that India has to import for its own use over 4,000,000 lbs. of tea from China, and practically no effort is made to check this very considerable importation. I have long felt that a serious mistake was made by the planter in so elaborately separating his teas into different qualities. He exposes his better teas to be used up for the purpose of improving the quality of the most inferior China teas. His own poorer qualities fetch next to nothing, and the demand for Indian tea is thereby greatly lessened. Were the Indian tea planters to strive to make their individuality felt by mixing their good and bad teas, and issuing a fixed and known medium brand, it may be confidently assumed success would be more certain.

Indian coffee seems in a more hopeful condition than it has been for many years. The precipitate closing of Ceylon plantations in order to convert these into tea gardens has effected a wonderful improvement in the Indian coffee industry.

Indian tobacco has attracted very considerable attention of late years, and the cigars are now more carefully made than formerly. They compare favourably with a British made cigar of the same value, and have but one fault—they are too conscientiously filled. The filling is packed too hard longitudinally, and the weight is thereby increased to a point that renders the cigars almost unprofitable. Were the Indian manufacturer to follow the example of the British and American manufacturers, and import (until he has learned to grow) special leaf for his covers, and at the same time practice the art of packing more loosely, he would find greater favour both with the English consumer and the tobacconist. It is impossible to speak in equally favourable terms of the leaf tobaccos shipped from India. The art of curing is but imperfectly known with the multitude of growers; carelessness, and perhaps a desire to increase the weight, disfigures each consignment, while a ruinous amount of mud, and the thick leaf stalks left dangling at the ends of the leaves, so increases the weight and raises the duty, that Indian tobacco can scarce pay duty, without giving the planter anything for his labour. As if these were not enough imperfections, the leaf reaches England in such a rotten and broken condition, that in the great majority of cases it is worthless. In spite of all these hard sayings, Indian tobacco has a vitality in it which bespeaks a great future, and the losses which it has had to sustain will, it is hoped, force both growers and manufacturers to more determined efforts.

Under the heading of drugs, allusion may be made to cinchona only in passing. A few years ago, after much trouble, Government succeeded in introducing a few live cinchona plants into India. The late Dr. F. Royle, in 1852, first recommended that an effort should be made to cultivate cinchona in India, but nothing was done in that direction until 1859. Cinchona has not only been successfully introduced into India, but has been so overgrown that the bark has fallen to an almost ruinous extent. The benefit to India of her cinchona plantations cannot, however, be over-estimated, but it is much to be regretted, in the interests of the fever-stricken millions, that the tremendous fall in the price realised by the bark has not been accompanied by a corresponding fall in the price of the alkaloid. With the exception of opium, no other drug of any importance is cultivated in India; but it cannot be too strongly urged that the people of India are made to pay too dearly for their drugs, since most of the drugs which might easily be grown in India are entirely imported from Europe. Even aconite, a wild plant in Nepal, seems to be first exported to England, and then re-imported to India. While little reliance can be put in the bulk of the drugs collected in the jungles by the people of India, a distinct per-centage of them, if more carefully investigated, might fairly come to take the place of the expensive imported medicines, and thus for the same money admit of dispensary aid being extended to a much larger community than is the case at present. A few of the more important drugs of India have been sufficiently brought to the attention of the medical authorities of Europe to require little more than to be here mentioned by name, such as *chaulmugra* oil; *bael* fruit; datine, from the bark of *Alstonia scholaris;* the bark of *Caloptris gigantea;* the bitter roots of the *Mishmee teeta;* the bark and seeds of *Holarrhena antidysenterica;* the bark of *Hymenodictyon excelsum;* the *kamela* powder (a useful anthelmentic and vermifuge); the flowers and leaves of the *gao-zabân;* the tonic roots of the *Picrorhiza Kurrooa;* the *ispaghul*, a useful and simple drug in the treatment of dysentery; the healing oil from the seeds of *Pongamia glabra;* the astringent bark of

Soymida febrifuga. These and a few other indigenous drugs, if they are never likely to become articles of export trade, might at least be more generally used in dispensary practice, so as to lessen the charges on imported drugs.

The subject of Indian hemp may here deserve a passing consideration. The narcotic from this plant is extensively used by the people of India. The extract secreted on the female flowers constitutes the *ganja*, which is smoked; the dried leaves constitute *bhang*, the substance employed in preparing the intoxicating beverage known as *hashish*, and the intoxicating sweetmeats *majun*. *Charas* is a special resinous substance, prepared in Northern India, and is more expensive and more intoxicating than either *ganja* or *bhang*. The European medicinal preparation—the extract—is reputed to have recently fallen off in strength, so much so, that it is far less used than in former years. This may be accounted for by the fact that in Bengal, where the best qualities of *ganja* and *bhang* are grown, a duty which amounts to as much as £30 to £40 on each maund is realised by Government, whereas in Madras no duty whatever is collected, and only a nominal duty in Bombay. This has doubtless led to the better and more expensive forms ceasing to be exported to Europe. There is little doubt, however, that if this were to be corrected by Bengal *ganja* being procured, the extract of its former quality might easily enough be produced. It is customary to see in the returns of Bombay mention of exports of Bengal *ganja*, but as the price quoted is only about 2s. a pound, and no *ganja* can leave the Government stores in Bengal until it has paid a duty which, together with the charge for cultivation, brings every sixteen ounces of the article up to a price close upon £1 sterling, the so-called Bengal *ganja* exported from Bombay cannot possibly have come from Bengal, a fact which is worthy of careful consideration by persons wishing to manufacture the liquid extract of Indian hemp.

Class III.—Fibres.

At this late hour it would be useless to attempt to deal with cotton, jute, silk, and wool. There is so much to say under each of these subjects, that it would take hours to deal with them satisfactorily. I cannot, however, pass from the subject of cotton without reminding you that the great cotton mills of Bombay have already given promise that each year the Indian mills will more and more meet the Indian market, until they begin to materially affect the immense import trade in British cotton goods. The imports of cotton goods into India were last year valued at £24,282,628, a large enough trade to invite competition in every direction. The British manufacturer has not so much to fear, however, from native enterprise, at least for some years to come, as from British. Just as happened with the jute trade of Dundee, Englishmen with their capital and machinery may remove to India to manufacture from Indian cotton the peculiar goods required by the people of India. When this is done, there will be a saving in time and of freight charges and agency, The raw cotton, instead of bearing freight to England, and the goods freight back again to India, together with the charges for agencies and brokerages which these transactions necessitate, would be produced and manufactured on the spot, and go direct into consumption. I have endeavoured to show that the difference between the cost of Indian and English labour is not so great as is commonly supposed. The advantage is, however, in favour of the mill-owner in India, and the disadvantage against the hand-loom weaver. To put this matter clearer, the cheapness of Indian labour is not sufficient to enable the hand-loom weaver to hold his own against the power-loom manufacturers; but Indian labour is cheaper than English, and this cheapness is another advantage which the mill-owner in India has over the British manufacturer.

There is no more hopeful future for India than the opening out not of cotton mills only, but of factories of every description. It is impossible for India to stand still. Each year will see her becoming more and more a manufacturing country. The world has, however, grown tired of using cotton, jute, silk, and wool. A distinct demand has arisen for new fibres, and India possesses at least 300 fibres, few of which have as yet received even a passing consideration. At the late Colonial and Indian Exhibition the largest and most complete display of the fibres of India ever shown was placed before the public. These fibres attracted very considerable attention, and experts from all parts of the world were afforded every possible facility in examining them. It will be enough to allude to three of these fibres.

1. *Sida rhombifolia*.—This beautiful silvery white fibre is obtained from the above-named plant—a member of the mallow family. Botanically *Sida* may be said to be allied to jute, and

the fibre it affords, in many respects, resembles jute. It may be grown on the same fields, and by the same cultivators. It can, therefore, be produced at about the same price, for the fibre may be separated from the stems by the same simple process, namely, by retting and washing in water. The only factor that might conduce to make it more expensive than jute is the fact that, in its wild state, it does not attain the same length of stem as the cultivated jute; but *Sida* has not been cultivated as yet, and there is no knowing but that it may even exceed jute in its yield of fibre per acre. It may be accepted, however, that *Sida* fibre is, like jute, a cheap fibre, and one that might be produced with great ease in immense quantities, the supply being as constant as that of jute. Its claims for superiority over jute are very considerable. The fibre is not half as thick as jute, and it is of a much purer quality, and can therefore be spun into finer yarns than jute, and thus come into textile purposes which jute has totally failed to reach. It can take colour with great ease. In fact, *Sida* fibre has been much admired by all the manufacturers who have examined it. It is now being experimented with on both flax and jute machinery; and I am hopeful that, as one of the tangible outcomes of the late Exhibition, this fibre will, in a very few years, come to hold a distinct place amongst the fibres exported from India.

2. *Bauhinia Vahlii.* — This extensive climber belongs to the family of the pea. It abounds throughout all the warm lower mountainous tracts, being the most abundant climber in the mountainous forest of the great table land of India, and crossing the Gangetic basin, it occurs again in all the forests which skirt the foot of the Himalaya. Mr. Routledge, of Sunderland, was, I believe, the first person who within the past few years drew prominent attention to the fibre derived from this plant. Long before even Mr. Routledge's attention was directed to it, however, the late Dr. Forbes Royle spoke highly of it under its vernacular name, and specimens were exhibited at the Great International Exhibition of 1851. The fibre is universally used by the natives of India for the purpose of ropemaking, and it stands high in their esteem. Mr. Routledge has urged its use in the paper trade; but although the plant is sufficiently abundant to warrant the idea that it might even pay to be thrown into the paper-makers' vat, it seems to possess such merits as a possible textile fibre, that it is more likely to find a much higher place than Mr. Routledge designed for it. The *malu* fibre may be gathered in immense lengths, for the plant is one of those gigantic climbers which, by means of its tendrils, extends its long arms from tree to tree, binding the forest into great clumps. It is, indeed, a source of greatest annoyance to the forester, for it not only injures his trees, but has such a vitality that it is next to impossible to exterminate the plant, and a few months after it has been cut to the ground, its long elegant pendant boughs, laden with its great clusters of white flowers, are seen waving in defiance from the topmost branches of the trees. A very large and practically inexhaustible supply might be drawn from the forests of India, but I have no confidence in a large industry depending upon a wild plant. The wide area over which it would have to be collected, and the complete control which the owners of the forests could exercise over the buyer, would be dangerous to success; therefore a tract of country, say twenty miles, of the practically useless stoney hill sides would have to be purchased and systematically planted. A forest is not necessary for the plants to climb on; they would trail over the ground and form with each other great clumps. From such a plantation a nucleus of supply could be drawn and depended upon, which would have a good moral effect upon the persons bringing to the planter supplies from the wild source. In this way it is possible to procure a constant supply, and if this can but be secured, the fibre possesses in itself such high merit that it will soon make itself known in the textile world. It is one of the few vegetable fibres that will stand to be dyed, bleached, and worked up along with wool, a property which speaks volumes in itself.

3. *Caloptris gigantea.*—The world has heard so much of the *madar* fibres that it may be viewed as presumptuous on my part to desire to go back upon the unfavourable verdicts which experts have passed upon them. It is well known that the stems of this plant afford one of the strongest and finest of vegetable fibres, and one of the most beautiful. The great difficulty is to separate this fibre from the stems, and, indeed, so great is this difficulty that the idea has practically been abandoned. My friend Mr. Cross, by nitrating *madar* fibre, has, however, produced a substance which can with difficulty be detected from silk. It has all the gloss and softness of silk, and would seem so valuable that, in this state, it could

well afford to bear an expensive process of separation.

I desire your attention not so much, however, to the possibilities of *madar* bark fibre as to the floss found attached to the seeds. This has been pronounced too short and too light to be worked on machinery. But I have begun to suspect that we can correct these defects to a large extent. The plant is wild along country roadsides in India, luxuriating on every bit of waste sterile land. No person, as far as I am aware, has thought of cultivating it. An important Lancashire spinner has assured me that, even in its present state, he can use any amount of the fibre; all he requires is a uniform and steady supply. We have agreed that this can never be secured from a wild plant which has to be collected by wandering along miles of roadsides. Through the kindness and co-operation of a missionary friend, however, I am at present having a few acres of inferior land cultivated with *madar*, and we are hopeful of being able to prove to the poor Santals of Bengal that this crop would pay them far more than some of the things they and their forefathers have been in the habit of growing. If this can be done, uniformity and continuance in supply may not only be secured, but it may be confidently hoped that, with careful selection of seed, after a few years, we may educate the plant into becoming obedient to man's skill. Our cultivated *madar* may yield a floss that will have none of the defects complained of. If this can be done, I am satisfied my friend will do it, for I know of no more careful and painstaking person in India than the gentleman who has most generously undertaken to pioneer the introduction of this new annual crop.

Class IV.—The Oils and Oil-seeds.

But I have already trespassed too far upon your time. There is much that one might say about the existing crops and the possible new crops of India, that one scarce knows where to begin or what to say first. Speaking of the oil-seeds, however, the greatest possible interest was taken at the late Exhibition in the white form of linseed sent from the Central Provinces. Were it possible to develop this form to the exclusion of the red, a large trade would be done in it. The greatest danger to the Indian oil-seed trade is the difficulty to induce the people to discontinue their practice of adulteration, or to persuade them to be more careful in rooting up different crops growing in the same field. A comparatively small per-centage of rape seed mixed with the linseed renders it completely useless as a drying oil. Speaking of the rape seed trade, on the other hand, few persons seem to be aware that there is, practically, no mustard grown in India. The so-called mustard exported from India is in some cases better qualities of rape, or in others the Indian mustard—the small black and pitted seeds of *Brassica juncea*. It seems desirable that this fact should be made more generally known for should demand arise for *Brassica alba* or *B. nigra*—the true white and black mustards, these might easily enough be substituted for the white and black forms of *B. campestris* or rape seed, which seem to find a market as inferior mustard.

I have to thank you for your patience in listening to me so long, and to apologise for the necessarily rambling nature of a paper which professed to deal with so extensive a subject as "The Economic Resources of India."

DISCUSSION.

Mr. Martin Wood said every one must feel grateful at the position to which this subject had been brought since the time when the Chairman was preparing his "Catalogue of the Vegetable Products of the Bombay Presidency." Much, however, yet remained to be done, for though much knowledge had been acquired, it still had to be applied. Many people were now considering very carefully what could be done in the way of evoking that sort of co-operation and painstaking perseverance amongst the people which was so much required to overcome the indifference and carelessness of the native population. That was the difficulty in detail; but he considered that, in a country administered as India was, Government supervision might be carried to a greater extent than it had been. Dr. Watt had pointed out that this agency was being put into operation to a greater extent than heretofore; but unless the people themselves could be interested, and the operations of the Government conducted through some intelligent native agency, he did not see how the people could be got hold of so as to develop these hitherto neglected sources of wealth. There was now material in the educated native population, men who had been trained in the Medical and Engineering Colleges, who, he thought, would be admirably adapted for this purpose. A criticism had been passed on some of Dr. Watt's proposals, as developed in his lecture at the Colonial Institute, which criticism was very ably stated in the *Pioneer*, the question being put, "If the Indian people would really be benefited by doing everything themselves, what became of the theories which measured the

prosperity of a nation by the amount of its import and export trade, and which still seemed to find general acceptance amongst English economists." He could see partly how that question might be answered, but he should be interested in hearing Dr. Watt's views upon it. He had already partly anticipated it, because instead of dealing mainly, as he had, in the former paper, with the development of native industries and indigenous arts as applied to things which served the people themselves, he had now dwelt more on those which tended to enhance the export trade. The main question, after all, was how to interest the masses of the people in these sources of wealth which surrounded them, and which might be so enormously developed by the aid of western science. The difficulty was to find out how that process was to be stimulated, for it was already to some degree inaugurated. These products required to be developed both for use in the country itself and for export. Dr. Watt had tried to bridge over the great gulf which appeared to exist between the steam-driven agencies of the western world and the simple mechanical contrivances of India, but he admitted that that gulf must still exist to a great extent, for although coal and iron existed in India, they were so difficult of access that they could not be taken into account in any extensive way. He had seen the paper announced as on the economical condition of India; and, after all, calling attention to her economic resources was the way to modify and improve her economic condition. But he would remind the members that below this question lay the general principle that industry was limited by capital. If India were short of capital—if her resources were lessened or prevented accumulating, any industry, and especially a new industry, must be checked at every turn, and so it always was in India. The one prevading difficulty was the want of capital, and that the capital needed for experiments whether with fibres, seeds, oils, or other matters, was so dear. It was also desirable to point out that as the exports so largely exceeded the imports this deficiency of industrial capital is inevitable. In the three years ending last March, the exports of India exceeded the imports (treasure included) by fifty millions and a-half, or nearly seventeen millions a year, a condition of things which scarcely obtained in any other country in the world. This was the dead weight against which the industry of India had to struggle; but in spite of that, they should not lose heart; but rather use every endeavour to evoke those latent forces, and develop those latent resources which lay waiting to be utilised.

Sir JOSEPH FAYRER, K C.S.I., F.R.S., said he had been much interested by this paper, and congratulated the Society, India, and also England, on having one so eminent, so practically fitted, and with such a large amount of common sense, to deal with this great subject. If there were a few more who would travel over the country with their eyes open, and take a practical common-sense view of matters, excellent results would follow. He, like many others, had been long conscious that there were immense resources in India not developed—that the surface of the country was scarcely scratched. These resources only needed development, but it required energy and capital to do this. It was to be hoped that this would come in time, and the first necessity was to call attention to it. He had been particularly struck with one or two subjects in the paper, for instance, the use of gram for feeding horses; it was a much better food than that used in England, being more nutritious, and it would be a great advantage if the English would feed their horses on gram rather than on oats and crushed Indian corn. Any amount of this pulse could be produced in India. For wheat, of course there would always be a great demand, as it was the proper food for the inhabitants of a cold country. The people who lived in the colder parts of India lived on wheat, rice being the food of only a comparatively small proportion of the people, those who lived in Bengal, or in other tropical and sub-tropical regions. He was particularly interested in the question of drugs, which had come more or less under his own observation. He knew when he was in India that many drugs, which were to this day exported from England at great cost could be made there from native plants just as well; for example, he remembered growing *hyoscyamus* in the public garden at Lucknow, and it grew beautifully. He had quantities of the extract made and sent down to Calcutta, where it was investigated and found to be as good as the extract which came from England. Still it was not made there to this day. Not long after he came to this country, and assumed charge of his duties at the India-office, it seemed to him his duty to point out that there were a great many things of this kind exported which might as well be grown in India; and he believed something was now being done in this way, factories and laboratories being established where drugs could be prepared on the spot, so that the plants need not be sent to England to have the drugs manufactured, and re-exported. He knew that efforts had been made to manufacture quinine in India, and there was no reason why it should not all be made there. Not only quinine but a most valuable drug was made from the cinchona plant, of the mixed alkaloids, which was of service in the treatment of fever. That, he believed, was made in large quantities in India, and was much used, as in many cases it replaced quinine very well. If the same perseverance were exercised as regards other things, there was no reason why many others should not be treated in exactly the same way. He was very glad to meet Dr. Watt again that evening, having heard him read a paper not long ago at another society, where he was much struck with his powers of observation, the intelligence with which he looked at things, and the plain common sense he brought to bear upon them.

Mr. J. F. HEWITT, owing to the difficulty mentioned in the paper of bringing clean wheat from India to England, and the proposal that the Government should make arrangements for having it clean, said no doubt it would be an excellent thing if this could be carried out, but he feared Government influence could not extend so far as to the cleaning of all the wheat. Wheat was grown over an enormous extent of country, and was brought from very long distances to the railway, and it would be an endless business to clean it all. No doubt something might be done, especially at the great centres. He thought the greatest hope of any improvement in that direction was its being done by the people themselves. Government could not help the people much, it could only act something like a schoolmaster, and a schoolmaster could only teach a boy when he was young; as people grew up they must teach themselves. He saw great hopes for the future in the movement now begun in Bengal, for he observed in the last papers from India that two young men educated at Cirencester had now established a school for practical agriculture in Bengal, which promised to work exceedingly well. If a movement of that kind were extended over the country, no doubt its influence would be very widely felt. He had a strong belief in India becoming a manufacturing country; the coal fields were very extensive, in Bengal alone covering over 5,000 square miles, and they were all practically in a ring fence, and a railway of a little over 100 miles would bring that coal to Benares. If manufactures were worked with this coal, they might be exported down the railways and rivers, and distributed all over the country. A great part of India was over-populated, and those who lived on the land could not find proper subsistence, and if they were to get employment in manufactories, it would be an immense advantage to the country, for he was perfectly certain that as soon as the coal fields were connected by railway with the other railways and water carriage, manufactories would be established, and an immense improvement would result.

Colonel LE MESSURIER, R.E., said that the gradual development of railway communication in India had led the natives to invest in these undertakings, of course to a small extent at first. He believed that much of the money taken to India and deposited in the temples would eventually be advanced for investment in local lines. The natives of Mysore were most anxious to possess stock in the railways of that province. With regard to gram, he might say that in Southern India it was almost unknown as a food for horses, but another grain, a pea called *kooltee*, was used extensively for that purpose.

Mr. F. CLIFFORD said he had been much impressed by Dr. Watt's description of the boundless resources of India, apart from the particular article—coffee—with which he was connected. It seemed to him that India, venerable as she was amongst the nations, was only yet in her infancy as an exporting country, commercially speaking. Of vast importance to British producers was the fact stated as to the wealth India was gradually accumulating by the payments for her exports. What had she done with that money? and what would she do with it, assuming this rate of payment for her industries continued? What they had just heard threw some light on that question, because if the Indians, who were so secretive and so much inclined to hoard, were now taking courage to invest in loans and in railway and Government stocks of various kinds, they might soon be tempted to go a little further, and to invest in those co-operative and industrial enterprises of which there were so many examples in England; and the moment India did so, she would become a most formidable competitor to this country in manufacturing industries. She had boundless resources at her doors, which she would not send here in the raw condition, but would very soon begin to manufacture, and to compete with England on a colossal scale. That opened a vista of which Dr. Watt had given very pregnant examples, so that it was impossible to go away without far larger ideas of the value India was to this country, and of the immense future before her as another element in the greatness and glory of this realm.

Captain TEMPLE said he was very pleased to hear Sir Joseph Fayrer draw attention to the great services of Dr. Watt in developing the economical resources of India. As one who had seen something of Dr. Watt's work, he could assure the Society that there was no one more qualified to speak with authority on the subject he had chosen. He had seen him at work on his great dictionary of the economic products of India, and anyone who would open that book at any page would be astonished at the extraordinary amount of information it contained. Full details on every conceivable subject connected with the plants, or the articles and manufactures which could be produced from them, were to be found in that book. One or two points in the paper he might remark upon. Dr. Watt said, in spite of the desire to conserve native art, the natives of India were taking more and more to steam power, and no doubt this was the case. Whatever might be desired from an artistic point of view, there was a tendency on the part of the natives to take to manufactured goods as the term was understood in Europe; that meant that the articles they were turning out were getting more and more under the influence of European art, and that being so, the best thing for Europeans to do was to try and make the natives keep to their own patterns as far as possible. That this could be done when Europeans and natives worked conjointly, had been shown by the work in gold and silver turned out by Messrs. Orr, of Madras, and Messrs. Hamilton, of Calcutta. There you had a good example of what a native could do

in the way of accurate workmanship under European superintendence. Allusion had also been made to the great difficulty presented by the prejudice of the natives against migrating from one part to another, but these were not insuperable, because in some cases they had done so on a large scale. For instance, the Sirsa district of the Punjaub had been practically populated, since we took over the country, by the Sikhs, who brought into their new villages their old ideas, creating a new district in exactly the same fashion as Indians had done for the last 2,000 years. Again the inhabitants of Madras had migrated in large numbers to Burmah, where they made a very good living, and the inhabitants of Nepaul of all classes had populated the Darjeeling district within the last thirty or forty years. As regards the increasing prosperity of the people, he could speak, as a magistrate of the Punjaub, as to the general rise in the wages of unskilled labour, which was to be seen going on now; so that every few years they were obliged to raise the wages of the punkah coolies, whose labour was about the most unskilled in the world. With regard to the cleaning of wheat in the Punjaub, there was not a magistrate who had not over and over again impressed on the native growers the enormous importance of cleaning their wheat, and bringing it in a better condition into the market, but the answer always was that there had grown up a certain per-centage of dirt in wheat which the merchants would always insist on taking off whether it was cleaned or not, and, therefore, the growers said it would not pay them to clean it, for if they did the only person who would benefit would be the merchant. He was glad that Dr. Watt had removed the common error that rice was the staple food of India. In the part of India he had had to deal with rice was a luxury, the principal food of the people being millet, pulses, various kinds of wheat and cereals. With regard to tea, the natives of India were very fond of it, as most Europeans knew from the way in which native servants would steal it whenever they had the opportunity. They drank it in large quantities, but they liked a peculiar quality, which was ascertainable by the people who grew it; for he had seen himself in the Kangra district a native owner who made a tea estate pay because he supplied the kind of tea which the people in the Punjaub like; whereas the European tea planters did not do so, and while they were complaining that they could not find a market, this native grower was making a very good thing of his tea.

Mr. J. T. Wood remarked that one of the articles referred to—tobacco—was one which illustrated in a remarkable degree what Dr. Watt wished to see accomplished. He understood the reason that Indian tobacco did not hold its due place in the market was the carelessness with which it was prepared. He noticed, three years ago, the amount of tobacco imported into England from all countries amounted to 26,000 tons, valued at 8d. a pound. Looking back to a book published in the year 1825, he found, in the time of the American war, tobacco was grown on the banks of the Tweed at a profit, though by Act of Parliament all produced had to be sold to the Government in the first instance, at 4d. a pound. In India, during the last year, 26,000 tons were carried on two railways alone, while the 500,000 acres of land said to be under tobacco cultivation in that country probably yielded 100,000 tons, part of which was valued in Dr. Balfour's book, at the present rate of exchange, at only 1½d. a pound. The contracts with the French and German Governments were sometimes as low as 2d. a pound. Considering that India had a climate that was so adapted to the cultivation of tobacco, and that some grown there was equal to any produced in America or elsewhere, it seemed to him if Dr. Watt's suggestion were carried out of instilling into the natives more careful preparation, India might do in this case what it had already done in the case of tea and wheat, and be able to compete successfully in all the markets of the world in the sale of tobacco.

The Chairman said they had to thank Dr. Watt for a most valuable paper. The importance of its subject could not be exaggerated. The area of India was nearly 1,500,000 square miles, and its population over 250,000,000, and the reproductive force—the greater part of which still remained latent—represented by these prodigious figures was at the absolute disposal of this country. India was, in fact, the greatest prize of our commercial empire, and it was in vain to attempt to disparage its importance by any comparison with our Colonies. The growth of the latter in the last fifty years—and it is just fifty years since the city of Melbourne was founded—has been something marvellous; but the present races of men are nearer 50,000 than 5,000 years old, and after so long a lapse of time we may well expect that those countries of the world which have no historical past will have no historical future, and that, notwithstanding their commercial value, they will remain to the last mere "plantations," providing a welcome Euthanasia for the surplus populations of the nations of the Old World. Of course the Aryan races, which are the youngest of all, may yet re-populate the used-up continents of the so-called New World and Australia. But the discouraging fact remains that the whole of vertebrate land animals of the Americas have, excepting in a few favoured regions like Canada, gradually dwindled down to inferior types, as compared with those of the younger Old World; and no one can doubt that in these countries sterility is the rock ahead for both man and brute. India will, therefore, probably always remain of supreme importance to England, as the mainspring of the international trade of the Old World. The question, however, which most engaged his sympathy, was as to the effect which the future development of our com-

merce with India will have on the latter country. His own fear was, that when India is once drawn into the vortex of the keen competitive civilisation of the West, we shall have seen the beginning of the end of the antique co-operative civilisation of the Brahmanical Hindus. Several years ago he expressed, in a letter to the *Athenæum* on the Ajanta cave paintings, his belief that the Buddhistic revolution in India was the result of the great free trade between the East and the West organised in the 7th and 5th centuries B.C. by Psammetichus I. in Egypt and Nebuchadnezzar the Great at Babylon. This trade commercialised Judaism as Christianity wherever it was leavened by Hellenism, and as Mahomedanism wherever it remained unleavened by Hellenism. In India it gave to Hinduism the commercial or international form of Buddhism, which continued to flourish in India until the overland trade of antiquity between Europe and Asia was disorganised, and gradually destroyed by the rise of the devastating Saracen and Mongol and Turkish dominations. The Code of Manu represents the Brahmanical reaction against Buddhism during the gradual commercial isolation of India following on the breaking up of the old overland routes; and nothing could be more suggestive than the intensely anti-commercial spirit which inspires it. But if Hindustan is once again undermined in India, it will be over-thrown never to upraise itself again. This would be impossible in the face of the Western influences concentrated on the country, through its political and commercial connections with England, Australia, the Cape of Good Hope, Russia, and the countries of the Mediterranean Sea; and unsupported by their ancient co-operative institutions, the race of Brahmanical Hindus, which has been formed by these institutions, will be reduced to a disorganised horde, and perish altogether. As a tropical and semi-tropical race, they are quite unequal to stand unsupported against the unrestricted force of the competition of the manufacturing and mercantile races of the North. The Brahmans are already beginning to recognise this, and hence their unavailing pathetic lament over the pollution of "the four castes," by the use of European goods. He hoped, therefore, that Dr. Watt was correct in his anticipation of India gradually becoming independent, for Hindu use, of the importation of European manufactures. He cordially endorsed the recommendation that we should do more in the future for technical education in India. The people of India want no education in the decorative arts; while in this respect we have much to learn from them. But in carpentry and joinery, and the mechanical processes generally of the decorative arts, they require instruction. Our present costly eleemosynary State education in India was, in his opinion, too exclusively scholastic; and its tendency had been to unduly attract the rising generation of the people of India from their hereditary handicrafts into our schools and colleges, in the hope of securing, through a high-class English education, employment in the public service; a hope which, in 999 cases out of 1,000, must be disappointed. The injurious effect of our educational system is very clearly seen where, as in the case of the Parsees of Bombay, the community affected by it is restricted to a narrow area, and limited numbers. He remembered "the Parsees" in the time of their ignorance, when they commanded all the sources of wealth, in the handicrafts, the trades, and the mercantile professions, of the town and island of Bombay. Now these are all passing out of their hands, and simply because their English university education has brought them to despise their ancestral avocations, and to covet Government employ as the *summum bonum*. In conclusion, he had only to express to Dr. Watt the thanks of the meeting for the singularly interesting and most impressive paper which he has just read to us. He had shown a thorough mastery of his subject, and the mercantile public of this country, as well as the Society, would be grateful to him for the service he had rendered to them that night. He wished Dr. Watt a pleasant voyage on his return to Calcutta next month, and a long career of usefulness and distinction in India.

The vote of thanks having been carried unanimously,

Dr. WATT said it was hardly necessary for him to reply. He had had great pleasure in preparing this paper, and had been abundantly rewarded for any trouble he had taken by the extremely kind appreciation of it that had been shown.

FOREIGN & COLONIAL SECTION.

Tuesday, February 15, 1887; W. T. THISELTON DYER, C.M.G., F.R.S., in the chair.

The paper read was—

SOME OF OUR COLONIAL WOODS.

By ALLEN RANSOME.

Having been much struck with the countless varieties of fine woods exhibited at the Colonial and Indian Exhibition last year, it occurred to me that many of them might with great advantage be introduced into this country in conjunction with, or in place of, the comparatively few foreign woods which have too long enjoyed a monopoly of the English market.

As a first step in this direction, I offered to the Executive of the Royal Commission to practically test any samples of woods which they might like to submit for the purpose, by working them up by machinery into the various articles for which they appeared to be best suited.

Sir Philip Cunliffe-Owen laid this proposition before the Agents-General of the various colonies, who, one and all, showed their appreciation of it, by at once placing at my disposal samples of such woods as they considered would be likely (when better known) to find a ready sale in this country.

The representatives of the several Colonies at the Exhibition also gave their cordial cooperation to the scheme, and after some weeks had been spent in private experiments, a representative meeting of Colonial gentlemen, civil engineers, and others interested in the subject, was held at Stanley Works, to witness the working up of about forty varieties of the more promising timbers.

The trials included felling and cross-cutting large trees by steam-power; sawing out, adzing, and boring railway sleepers; the conversion of the various woods by vertical, circular, and band saws; making doors, straight and circular mouldings, match-boarding, framing, and other joiners' work; turning spokes of wheels, hammer-shafts, axe-handles, &c.; and the manufacture of tight casks for holding liquids.

It is the result of these trials which I have been invited to give you to-night, but I fear that this paper will be deemed somewhat unsatisfactory and incomplete, as it only extends to a few of such woods in each colony as can be obtained in large quantities; and while some of those which will be noticed are undoubtedly of great value, there are many others of equal importance of which no mention will be made, as the size of the samples submitted for experiment did not admit of their being practically tested.

The object of the experiments being, as above stated, to introduce to the notice of those interested in the subject woods which, although hitherto practically unknown in this country, might to advantage be brought into the English market, all such varieties as are already in common use were expressly excluded; and the scope of the trials was further limited by rejecting all woods which, from their scarcity, could only be regarded as curiosities.

It will thus be seen that this paper must necessarily be a very incomplete report, if regarded as referring generally to the vast subject of our Colonial timbers; but it is hoped that this defect will be somewhat compensated for by the fact that the information with regard to such timbers as are noticed is the result of practical experiment.

I think it well, however, to mention, that the statements as to the durability of the various woods, and their power to resist the ravages of insects, have been chiefly obtained from the printed reports of the wood exhibits issued by the various Colonies.

With a view to forming some idea as to how the different timbers would be affected by seasoning, pieces of the various woods were planed to the uniform size of $18'' \times 4\frac{5}{8}'' \times 1\frac{1}{2}''$, and after being carefully weighed, were submitted to the cool air drying process for 144 hours.

The results of these experiments are given in the Table page 289; but it should be mentioned that this portion of the trials can hardly be regarded as complete, in consequence of some of the samples being much more seasoned than others when placed in the drying chamber.

For seasoning the woods the cool air drying process was selected as being more like natural seasoning than any of the artificial means at present known, and it is noticeable that, though the test was very severe, the woods in some cases losing as much as 22 per cent. in weight, they have, with few exceptions, stood excellently.

With these few introductory remarks, I will now proceed to the consideration of the woods submitted to trial, classifying them under the heads of the different Colonies to which they belong.

Samples of the various woods submitted for trial will be found on the table, as well as a number of specimens showing the result of the experiments.

Canada.

Douglas Fir (*Pseudotsuga Douglasii.*)—This tree, which extends over a large portion of the Dominion of Canada, from the eastern base of the Rocky Mountains to the Pacific coast, is found in great abundance, and grows to an enormous size, some trees attaining a height of as much as 300 ft., with a girth of 40 ft. at the base, the trunk tapering but very little.

The quality of this wood differs very considerably, according to the locality in which it is grown, varying from a straight-grained, mild working wood, which might fairly compete with the best yellow pine, to a coarse-grained, harsh wood, little, if any, superior to our common Scotch fir. Another variety, a sample of which is exhibited, is beautifully figured, and might well be used for cabinet

LIST OF WOODS DRIED BY THE COOL AIR PROCESS.

Name of Wood.	Colony.	Weight when put in. lbs.	Weight when put in. ozs.	Weight when taken out. lbs.	Weight when taken out. ozs.	Condition when sent.	Remarks.	Shrinkage. Width.	Shrinkage. Thickness.
Bean Tree	Queensland	4	$12\frac{1}{4}$	4	$1\frac{1}{4}$	Very wet	Neither shaken or warped	$\frac{1}{16}$ in.	$\frac{1}{64}$ in. bare
Ironbark	New South Wales	5	$3\frac{3}{4}$	4	14	Wet	Very much shaken, not much twisted	$\frac{1}{16}$ in. full	A shade
Blackwood	Victoria	3	4	3	2	Dry	Slightly shaken and twisted	$\frac{1}{16}$ in.	A shade
Red Gum		4	$8\frac{3}{4}$	4	$6\frac{1}{2}$	Half dry	Not shaken or twisted	$\frac{1}{16}$ in.	$\frac{1}{32}$ in. bare
Blue Gum	South Australia	4	13	4	$8\frac{3}{4}$	Wet	Not shaken or twisted	$\frac{1}{32}$ in.	$\frac{1}{64}$ in.
Karri	Western Australia	4	6	4	2	Half dry	Somewhat shaken and twisted	$\frac{1}{16}$ in. bare	$\frac{1}{32}$ in.
Jarrah		4	$2\frac{3}{4}$	3	$10\frac{1}{4}$	Wet	Not shaken, slightly twisted	$\frac{3}{32}$ in.	$\frac{1}{32}$ in. bare
Tuart		5	$7\frac{1}{4}$	5	$1\frac{1}{2}$	Very wet	Not shaken, slightly twisted	$\frac{1}{32}$ in. full	$\frac{1}{64}$ in.
Black Pine	New Zealand	2	$14\frac{1}{2}$	2	10	Dry	Slightly shaken, not twisted	$\frac{1}{32}$ in.	Not at all
Red Pine		3	$1\frac{1}{2}$	2	$14\frac{1}{2}$	Dry	Not shaken, slightly twisted	$\frac{1}{16}$ in.	$\frac{1}{32}$ in.
Kauri		2	$14\frac{1}{4}$	2	$11\frac{3}{4}$	Dry	Perfectly sound, slightly twisted	$\frac{1}{32}$ in.	Not at all
Black Ash	Canada	2	$13\frac{1}{4}$	2	3	Wet	Not shaken, very slightly twisted	$\frac{3}{32}$ in.	$\frac{1}{64}$ in.
Douglas Fir, 1st quality		2	$3\frac{1}{4}$	2	$0\frac{3}{4}$	Dry	Not shaken, slightly twisted	$\frac{3}{32}$ in.	A shade
,, ,, 2nd quality		2	11	2	$7\frac{1}{2}$	Half dry	Not shaken, slightly twisted	$\frac{1}{8}$ in. full	$\frac{1}{32}$ in.
Yellow Wood	Cape of Good Hope	2	$6\frac{1}{2}$	2	$4\frac{3}{4}$	Moderately dry	Perfectly sound, very slightly twisted	$\frac{1}{16}$ in. full	$\frac{1}{64}$ in.
Stink Wood		3	6	3	3	Dry	Perfectly sound, slightly twisted	$\frac{3}{32}$ in. bare	$\frac{1}{32}$ in. bare
Billian	British North Borneo	5	$5\frac{1}{2}$	4	$15\frac{1}{2}$	Very wet	Surface shaken, not twisted	Not at all	Not at all
Russock		3	$0\frac{3}{4}$	2	10	Three parts dry	Perfectly sound, twisted	$\frac{1}{16}$ in.	$\frac{1}{64}$ in.
Serayah		3	$2\frac{3}{4}$	2	$12\frac{1}{4}$	Half dry	Sound, not twisted	$\frac{1}{16}$ in.	$\frac{1}{64}$ in.

work, and ornamental joinery, as a substitute for pitch pine.

During the trials, some of the wood was made into a door, while other portions were converted into straight and circular mouldings, and other joinery. Some boards were also passed through planing machines, and converted into match-boarding, with a feed of 40 ft. a minute, the work in every case being thoroughly satisfactory.

As yellow pine is becoming scarcer every day, it seems probable that the better quality of Douglas fir, may be largely imported into England, especially as the Canadian Pacific Railway passes through the forests in which it abounds, thus facilitating its transport.

Black Ash (*Fraxinus sambucifolia*).—This wood is found in great abundance in the woods of Nova Scotia, New Brunswick, Quebec, and Ontario, and from the fact that it only grows on a marshy soil, is frequently called "swamp ash." It is tough and elastic, and has already been imported to a limited extent into England. It is also asserted that it is occasionally sent over to this country as "white ash," the two woods being very similar.

The trees grow to a great size, but the soundest timber is to be found in logs of from 18 in. to 30 in. in diameter, as the larger trees are liable to decay in the centre. It is well adapted for agricultural implements, cart, wagon, and general wheelwrights' work; and, indeed, for all the purposes for which the best English ash is used; and, as it is found near the rivers in the eastern portion of the Dominion, the cost of carriage to the shipping ports is comparatively small, and the wood can therefore be imported into this country at a reasonable price.

Among the worked samples are hammer-shafts, pick-handles, straight and circular mouldings, match-boarding, and a small tight-cask for spirits, &c.

Iron Wood, or American Hop-hornbeam (*Ostrya Virginica*).—This tree, which seldom exceeds one foot in diameter, is found throughout Canada, east of Lake Superior. It is a light-coloured heavy wood, very tough and elastic, and is generally used in the colony for axe-handles, hammer-shafts, and other similar articles.

Some hammer-shafts and spokes made of this wood during the trials, show that it can be easily worked by machinery, and it is to be regretted that the piece available for trial was too small to convert in any other way.

West Indies (The Bahamas).

Horse-flesh Mahogany.—This tree, which is abundant in the Bahamas, rarely attains a height of more than 30 ft. It is a heavy, rather hard, and cross-grained wood, of a dark red colour, and is in high repute for ships' timbers, framing of houses, and general construction purposes, being impervious to all insects, and of very great durability; indeed, it is stated that after exposure to weather for over 100 years, it has been found perfectly sound.

A ship's knee, which was sent as a sample for trial, was cut up and converted in the following ways:—Straight and circular mouldings were run, leaving a most excellent surface, panels were planed with a like result, a piece of framing was mortised and tenoned, and some spokes turned, the wood proving in all cases easy to work.

British Honduras.

Red Wood.—This is a hard, close-grained wood of reddish-brown colour, with a good figure. The tree grows to a height of 60 ft. to 80 ft., with an average diameter of 1 ft. The wood is well worthy the notice of cabinet-makers, and the thin board sent for trial left the machine with a very smooth surface.

Ceylon.

With the exception of satin wood, which is already well known in the English market, none of the timbers of Ceylon are likely to find a sale in this country, for although there are many varieties, which from their fine figure, and diversity of colour, are adapted for ornamental furniture and cabinet work, they are, generally speaking, of small growth, and are not found in sufficient quantities to be advantageously imported into England. Moreover, some of the larger descriptions of trees which are worked up by natives of the colony, contain a great quantity of very fine grit, which quickly blunts the tools, and would render them very costly to work at the high wages paid to our skilled workmen. For the reasons just mentioned, I do not propose to describe further such Ceylon timbers as were submitted for trial.

New South Wales.

Mountain Ash (*Eucalyptus sieberiana*).—This is a tough, elastic, and durable timber, suitable for wheelwrights' and coopers' work, and general building purposes. From the specimen submitted spokes were turned, casks

made, and boards planed, with good results. The wood is plentiful throughout the colony, the trees attaining a height of from 150 ft. to 180 ft., with a diameter of 3 ft. to 5 ft. at the base.

Forest Oak (*Casuarina torulosa*.)—This is a handsomely figured heavy wood, of a light brown colour, mottled with dark red spots. The tree is found chiefly in the open forest of the northern and southern coast districts, and in the Blue Mountains, extending inland for a considerable distance. It attains a height of 60 ft. to 80 ft., with an average diameter of 2 ft.

Unfortunately, the sample sent was so small and shaky that it was impossible to subject it to much experiment, but a board passed through the planing machine left the cutters with a very smooth face. The wood takes a good polish, and is used largely in the Colony for veneers and cabinet work.

Ironbark (*Eucalyptus crebra*).—This is a hard, tough, heavy timber, found in abundance in the northern and southern coast districts, extending for a considerable distance inland. The tree attains a height of 100 ft. to 150 ft., with a diameter of 2 ft. to 4 ft. The experiments showed that this wood was well adapted for spokes, and other wheelwrights' work, and it is also used in the colony for railway sleepers, piles for piers, and other heavy timber constructions.

VICTORIA.

Blackwood (*Acacia melanoxylon*).—This wood is highly prized in the colony. Being close-grained, heavy, strong, and flexible, beautifully marked, and richly-coloured, it is much used by cabinet-makers, coach builders, coopers, and by railway carriage and agricultural implement makers. Samples of both old and young trees were sent for trial; the former were made into joiners' specimens, the latter into casks. The figure of the old growth wood was very fine, and the surface left by the cutters all that could be desired. The casks also proved a complete success. It is stated that timber of from ten to twenty years' growth is the most suitable for coopers' work, and as the tree is readily propagated, the supply could be made to keep pace with the demand for this purpose. Large quantities of this timber are found in Tasmania as well as Victoria. The wood, which seasons well, has already been imported into England in small quantities, and sold at the docks at from 2s. to 3s. per cubic foot, at which prices it would certainly be worth while to import it much more largely.

Blue Gum (*Eucalyptus globulus*).—This is a hard, light-coloured timber of great strength, tenacity, and durability. The tree, which is found in Tasmania as well as Victoria, attains a colossal size. By way of testing the samples sent, a sleeper was adzed and bored, and a panel planed. Both experiments proved very satisfactory, the latter especially so, as the wood was found to plane as well against the grain as with it. Being plentiful, it is largely used in the colony for beams and joists in buildings, and also for railway sleepers, piers, and bridges.

Red Gum (*Eucalyptus rostrata*).—This is a very hard, compact wood, of a reddish-brown colour, and is found throughout the colony, along river flats and open valleys. It is largely used for fencing posts, and is well adapted for engineering works and buildings when required to withstand a vertical pressure, although, on account of its short grain, it is not considered trustworthy to support a heavy transverse strain. It has the reputation of being the best of all the gums for railway sleepers, being almost indestructible in damp soil.

SOUTH AUSTRALIA.

Blue Gum (*Eucalyptus leucoxylon*).—This wood, which is also found in the colony of Victoria, where it is known by the name of "iron bark," is considered one of the most valuable woods in the colony, the trees growing to a height of 100 ft., with an average diameter of 3½ ft. It possesses great strength and tenacity, and has a close and straight grain, on which account it is largely used by the coachmaker and wheelwright for shafts and spokes. It is also extensively used for railway sleepers and piles.

The experiments on this wood were in every case most satisfactory.

QUEENSLAND.

Bean Tree (*Castanospermum Australe*).—This is a beautifully figured brown wood. The sample sent, being very wet, was tried under somewhat unfavourable circumstances. A baluster was turned from it, and some boards and panels planed, the work from both lathe and planing machine being excellent.

This wood should prove valuable to cabinet makers, but should be thoroughly seasoned before being used, as it shrinks very much in drying.

The tree, which is common throughout Queensland, is easily accessible, and can be conveyed by water at small expense from Brisbane and Maryborough.

Cypress Pine (*Frenela Robusta*).—This wood, which varies in colour from a light to a dark brown, is undoubtedly one of the most valuable woods in the colony, being straight grained, durable, beautifully figured, and easily worked. It is used extensively in the colony for cabinet makers' and joiners' work, and as it is stated to resist the teredo, it is particularly valuable for ship-building, piles, &c. The wood worked admirably under the action of the cutters, which left a beautifully smooth and glossy surface. The tree is abundant throughout the ranges of southern Queensland, and is easily accessible.

Western Australia.

Jarrah (*Eucalyptus marginata*).—This timber abounds in the south-western portion of the colony, and the best grows on the ironstone conglomerate hills, the finest quality being, as a rule, found at the highest elevations. Stems have been found measuring as much as 80 ft. to the first branch, with a circumference of 32 ft., at a height of 5 ft. from the ground.

Visitors to the Colonial Exhibition cannot fail to have observed a fine log of this timber, 5 ft. in diameter, which, with its polished end, of a deep claret colour, was quite a centre of attraction in the Western Australian Court.

The jarrah timber is hard, tough, and durable, and being proof against the ravages of the teredo, and white ant, it is highly esteemed for piles, dock-work, and ship-building purposes, as well as for railway sleepers and building constructions.

To retain the valuable properties of the jarrah requires a somewhat special process of seasoning; and it is above all important that it should not be felled during the rainy season.

The system of seasoning jarrah, which is found to give the best results, is as follows:—About four or five weeks before the tree is to be felled, it is girdled; thus effectually preventing any fresh sap from rising, and as the leaves continue to draw the sap out of the tree it becomes partially seasoned before it is cut down; as much as 3 lbs. of water per cubic foot, being extracted from the standing log in this manner. When the leaves have withered the tree is felled, and at once removed to the saw mill, where it is converted into scantlings or boards of the sizes required, which are then stacked, and entirely covered with sawdust until properly seasoned.

If not treated as above described, jarrah will remain imperfectly seasoned for many years, and if the heart is allowed to remain in the log, it cracks and splits to such an extent as to render it almost useless, while, on the other hand, if seasoned and converted in the above manner, it yields very sound boards and scantlings.

A portion of a jarrah pile which was taken out of Perth Bridge, over the River Swan, after having been for 35 years and 9 months between wind and water, was exhibited, and shows no sign of decay, nor trace of the ravages of the teredo; and a short piece of the same wood, also exhibited, which has served as a tram-rail on the jetty at Bussleton for 42 years, shows how very little it has suffered from the constant wear of the wheels upon it during that period.

Jarrah is frequently very handsomely figured, being shaded, or mottled with dark waves and veins, and notwithstanding its density and hardness, it is easily worked by machinery. It takes a very fine polish, and might be used to advantage for shop front fittings, counter-tops, and cabinet work. Its greatest uses, however, will undoubtedly be for sleepers and piles for harbour work, and as it can be imported and sold in this country for £6 per load of 50 cubic feet, it will probably, when better known, to a great extent supersede greenheart for dock gates, and other work for which the latter is now generally employed.

Karri (*Eucalyptus diversicolor*.)—This timber also grows in great abundance in the south-west portion of Western Australia, and when sawn up and partially seasoned, so closely resembles jarrah in appearance, that any one not conversant with both timbers, would find it difficult to tell them from one another, although in many points they differ materially. The karri grows to an enormous size, some trees being no less than 300 ft. in height by 60 ft. in circumference.

Energetic steps are now being taken to introduce both karri and jarrah largely into this country, and those interested in karri claim for it all the attributes and advantages of jarrah, and it must be admitted that it stands a greater transverse strain than that wood; but while its suitability for internal work is well established, it is open to question

whether it will last as long as jarrah in contact with the ground, or for marine structures.

Karri timber, in the shape of squared logs, flitches, and planks of various sizes, can now be bought at the docks at from £7 to £8 per load of 50 cubic feet.

Samples of both jarrah and karri timber, converted into straight and circular mouldings, match-boarding, spokes of wheels, and barrels are exhibited, and although both of these woods were readily worked by all the machines, the jarrah in every case left the cutters with a smoother surface than the karri.

The treatment above described for seasoning jarrah, is found advantageous in the case of karri, and it may be taken to apply to most, if not all, the varieties of the eucalypti, in which our Australian colonies abound.

Tuart (*Eucalyptus gomphocephala*).—This is another valuable timber tree, found principally between the Bunbury and Bussleton districts. It is of straight growth, and yields logs up to 46 ft. in length, by 24 in. to 30 in. square.

The wood is of a yellowish colour, hard, heavy, tough, strong, and of close texture, and for large scantlings, it will be found a most valuable wood, especially where great strength is needed. The tuart shrinks very little in seasoning, and does not split while undergoing that process. It also stands exposure to all vicissitudes of weather for a long time without being affected by it.

The experiments showed that this wood is well suited for wheel work, but its chief value would doubtless be for heavier purposes, such as the under framings for rolling stock, shipbuilding timber, piles for piers, and supports for bridges, and also as backing for armour-plated ships, as no ordinary shock or rebound will cause it to split; and as it can be sold in this country at from £7 to £8 per load of 50 cubic feet, it is probable that it will frequently be used in place of teak.

Raspberry Jam Wood (*Acacia Acuminata*).—This is a dark, reddish-brown wood, close-grained, hard, and having a fragrant scent, from which it derives its name. The tree, which is small, abounds in extra tropic Western Australia; it is easily worked by machinery, and leaves the cutters with a very smooth surface; and as it takes a fine polish, and can be purchased in this country at the low price of 3s. 6d. per cubic foot, it should find a ready sale among cabinet makers and others interested in ornamental wood work.

New Zealand.

Kauri Pine (*Dammara australis*).—This is undoubtedly the very best of all soft woods, and it is a marvel that it has not been more largely introduced into this country. It is found only in the province of Auckland, where the trees attain a large size, being frequently over 120 ft. in height, with a circumference at the base of 45 ft. It is remarkably straight-grained, and boards of any width and length can be obtained from it without a knot. Although a much stronger wood than the yellow pine of Canada, the kauri can be worked with equal ease, and its wonderful durability is proved by the fact that a hut erected on a cliff near Auckland by one of the early settlers in 1841, is still standing and in good repair, although it has been exposed to hot suns and beating rains for nearly half a century. A weather board from this hut was shown at the Exhibition last year, and is still perfectly sound.

Another useful feature in kauri timber is, that the end grain, when planed off smooth, never rises, and as it swells very slightly when exposed to moisture, it is eminently suited for engineers' patterns; in fact, kauri in all respects offers such great advantages over the best yellow Canadian pine, which has hitherto been almost exclusively used for pattern making, that I have decided to adopt it in my own works for that purpose, the more so as, strange as it may appear, kauri can at present be bought at a lower price than best yellow pine in the London market. The door, mouldings, and match-boarding made from this timber, which are exhibited, clearly show its suitability for all descriptions of joiners' work, while the cask, made from the same plank, proves that it can be used to advantage for coopers' work.

Kauri is used very largely in New Zealand and Australia, where it is much esteemed for flooring and deck planks, and it is estimated that, at the rate at which it is being felled, it will become entirely extinct in twenty-five years. It is therefore certain that if a demand arises for it in this country, the present low price of 3s. per cubic foot, at which it has lately been sold at the docks, will not long be maintained.

Black Pine (*Podocarpus spicata*).—This wood, which is also known in the colony as "matai," is somewhat hard for a pine, but is used extensively in the district where it grows for house building and joiners' work, and although it cannot be compared in quality

to the kauri pine, it is a good serviceable wood for that purpose.

Red Pine, or Rimu (*Dacrydium cupressinum*).—This is very similar to the black pine last described, and, like it, is used for joiners' and carpenters' work, the better logs being also used for cabinet-making. Pieces of both red and black pine were converted into mouldings, match-boarding, and framing, and although passed through the machine with a rapid feed, the surface produced on both woods was good.

Cape of Good Hope.

Upright Yellow Wood (*Podocarpus latifolius*).—This wood, which is plentiful in the forests of George, Knysna, and Amatola, is of a light yellow or straw colour, with an even grain, and is much esteemed in the colony for coach and waggon building, joiners' work, and bedroom furniture. Although the tree attains an average height of 75 ft. with a diameter of 2 ft., the trunk, up to the first branches, is rarely more than 20 ft. high. The wood is of a close texture, and works like mild lance wood, leaving the cutters with a remarkably clean surface, but the demand for it in the colony and the cost of transit would preclude its being imported into this country at a price which would pay, excepting for the highest class of joiners' work, for which it is well suited. A four-panel door, and some circular and straight mouldings, and match-boarding are exhibited as the results of the trials in this wood.

Umzumbit (*Milletia kafra*).—This is a remarkably hard and heavy wood, of such irregular growth that it more resembles the stems of six or more creeping plants grown together, than a single stem. The heart, which is small and irregular in section, following the deep indentations of the log, is of a deep purple colour, while the sap wood resembles an inferior quality of box wood. The wood is used for turnery work and small fancy articles, and being of a greasy nature, it is rapidly polished by simply rubbing with the hand. This natural grease, coupled with the hardness of the wood, makes it an excellent substitute for lignum-vitæ for bearings, and it may be interesting to state that the toe-bearing of the upright cutter-spindle, with which all the circular mouldings exhibited were cut, and which runs at a speed of nearly 5,000 revolutions a minute, is made of this wood. The result of some experiments with the diamond-polishing machines at the Exhibition, in which umzumbit bearings were used, showed that they lasted nearly seven times as long as those made of lignum-vitæ. The sample submitted for trial was so small that only a few tool handles could be made from it.

Sneeze Wood (*Pteroxylon utile*).—This wood, which is of a light yellow colour, abounds in Cape Colony and Natal, and being, from the peculiar pungency of its sap, impervious to the teredo and white ant, it is largely used for piles, fencing posts, and outside building constructions. Although hard, it works well, and is easily converted by machinery into joinery and cabinet work, but its irregular growth precludes its use for purposes where great lengths are required.

Stink or Laurel Wood (*Oreodaphne Bullata.*)—This is a heavy dark brown wood which, when polished, looks almost black. It is found in large quantities in the virgin forests of Izitzikama, and is used for joiners' and cabinet works, as well as for waggon and wheelwrights' work. It emits a very disagreeable smell when being worked, but this passes off very soon, and is quite imperceptible after the wood is polished. Another variety of stink wood is of a lighter brown colour, streaked with orange veins of various shades, and is much prized for furniture, gun stocks, &c., for which it is well adapted. The wood is heavy and remarkably tough, and is readily worked up into any form by machinery, but as it meets with a ready sale in the Colony at 3s. 6d. a cubic foot, it would not pay to import it into this country.

British North Borneo.

The virgin forests of British North Borneo abound in a variety of timbers of great size and value, and as they are situated conveniently for the port of Sandakan, where the wood can be delivered on board ship at exceedingly low rates, it is probable that ere long they will be largely used in this country, where, in spite of the long sea route, they will be able to compete favourably with some of the woods which we now import from other countries. Among the more valuable woods of North Borneo are:—

Billian, or Borneo Ironwood.—This is a heavy, hard, and durable wood of a dark sand colour, which, when seasoned, turns to a deep red, and with long exposure becomes as black as ebony. It bears exposure well, resists the teredo and white ant, and seems almost indestructible. It is said that the Chinese and natives of Borneo prefer this wood to any

other for almost all purposes; and it is invaluable for sleepers, beams, piles, and indeed, for any description of heavy construction on land or water. The wood, although hard, is easily worked by machinery, and during the trials, sleepers were sawn out, the rail seatings planed, and the spike holes bored, while other portions of the log were cut into scantlings, and mortised and tenoned together; and mouldings and match-boarding were run with a feed of 30 ft. a minute.

The result of seasoning a piece of billian 18 in. long by $4\frac{5}{8}$ in. wide by $1\frac{1}{2}$ in. thick, by submitting it for 144 hours to the cool air drying process, was that although it lost 6 ozs in weight, it was not perceptibly reduced in either width or thickness, and it neither split nor warped during the operation.

As this timber can be delivered on board ship in Sandakan harbour for £4 a load of 50 cubic feet, it can be sold in the London docks for about 2s. 9d. per cubic foot, at which price it should meet with a ready sale in this country.

Miraboo.—This is a strong and durable wood, with a pretty figure streaked with various shades of brown, and as it takes a fine polish, it is well adapted for furniture and cabinet work. In grain it somewhat resembles teak, and as it is easily worked, and can be sold in this country with a good profit for 2s. 9d. per cubic foot, it is likely to become largely used as a substitute for that highly-prized wood for railway carriage work, while it could be advantageously employed instead of mahogany for superior descriptions of joiners' work.

Greeting.—This is an excellent wood for building constructions of all sorts, as well as for framing for railway rolling stock, agricultural machines, &c. It stands exposure well, and is easily worked. Like the two timbers last described, greeting can be imported into this country in squared logs or scantlings of useful sizes at about 2s. 9d. per cubic foot.

Russock.—This wood, which when fresh sawn is of a light yellowish colour, but turns to reddish-brown on exposure, is extensively used in the colony for builders' and joiners' work. The tree, which grows to an average height of 60 ft. without a branch, is often as large as 4 ft. in diameter, and can be used for many purposes for which mahogany is at present employed in this country; and as it could be sold at the London docks at 2s. 9d. per cubic foot, it compares very advantageously with mahogany in this respect.

Serayah (*Selangan Batu*).—This wood, which is sometimes called "cedar," bears a strong resemblance to soft mahogany. It is a mild-working, straight-grained wood, and is suitable for joiners' work; and as it can be sold in quantities in the London docks at 2s. per cubic foot, it ought to prove a serious rival to best yellow deal for building purposes in this country.

Time will not admit of any mention of the many varieties of fine Indian timbers which were submitted to trial; but I trust that the foregoing remarks may lead to a useful discussion of this vast subject, which I am sure will be much more interesting and instructive than the somewhat monotonous report which I have had the honour to read before you this evening.

DISCUSSION.

The CHAIRMAN said he could only regret that Mr. Ransome had not given a fuller account of the interesting and valuable experiments he had made, particularly on the Demerara and fine Indian timbers, but no doubt they would hear of these later on.

Admiral MAYNE said he should like to say a word or two on the woods of North Borneo, though, as he had never been there, he could only speak from reports made to the North Borneo Company, in whose offices, he might say, were many samples of timber besides those mentioned by Mr. Ransome, though time had not admitted of their being experimented upon. The Company were firmly convinced that there were in North Borneo many woods of the greatest value, which only required to be known to be highly appreciated. The chief amongst them was billian, and with regard to that he would simply read a report which had been furnished to the Company from their agents at Singapore, which was as follows:—

Extract from a letter from Messrs. A. L. Johnstone and Co., dated Singapore, 22nd November, 1886.

"*Billian.*—We have made many inquiries from men in Singapore who are in a position to be considered competent judges of the value and durability of this timber, both in the sea and out, and, without exception, they are of opinion that when exposed to the action of the sea it is invaluable, as it possesses the virtue of resisting the worm, and the action of the water on the surface of the wood appears to harden more than soften it. The Tanjong Pagar Dock Company have used it most successfully in part construction of their wharfs, and the manager informs us that he is thoroughly satisfied with the results, which, so far, are beyond his expectations. Where this timber has been employed for planking, it has given every satisfaction; it will stand an immense

amount of traffic of heavy goods without showing any appreciable wear and tear. It has also been used as a fender, to protect the piles from friction when the vessels are moored up along the wharf. These fenders have been now in use some three or four years, and appear to be in as good a condition as when first placed in the water. In conclusion, we add that the close-grained billian is superior to the coarser, as the latter is apt to split when constantly exposed to the heat of the sun in the tropics. Billian is a remarkably heavy wood; it often is known by the name of ironwood. The timber sinks in the water, and is very difficult to work on account of its hardness. It is used, when obtainable, for piles in the ground, as it is one of the few timbers able to resist the attacks of the white ant."

At Singapore there had been the same difficulty found in introducing this wood that there always was with regard to anything new, but there was no doubt of its being the very best wood for any purpose where it was exposed. In Sarawak it was greatly used, and the Rajah had reserved certain rivers where it grew to prevent its being used too lavishly. A gentleman, who had lived many years in Sarawak, told him he had seen instances where, after being in use 100 years, it showed no signs of decay; in fact the marks of the adze were as clearly defined as the day they were made. The Chinese, in Sarawak, used nothing else for boxes, buckets, tubs, &c. The forests of billian, in North Borneo, were very extensive, and the utmost facilities were given for cutting it; in fact, the wealth of the country in timber was enormous, it merely required to be known and developed. For any purposes in which extraordinary durability was required it would stand pre-eminent. There were also many other woods, some of which took a very good polish, and would be found suitable for the linings of railway carriages and many other purposes.

The CHAIRMAN remarked that billian spoke for itself by the extreme beauty of its surface, and it almost seemed a pity that such a fine wood should be used for the purpose of railway sleepers.

Mr. DENT, of the North Borneo Company, said he could hardly add anything to what Admiral Mayne had said. It had been the belief amongst those who had lived in the East, as he had for many years, that the only wood which could be imported into England was teak; but Mr. Ransome had now told them, to his great surprise, that kauri timber could be laid down at a cheaper rate than Canadian pine. He knew the value of kauri pine, for he had seen houses built of it at Shanghai. He had noticed in the Australian papers that they found a difficulty there in getting wood suitable for casks, partly on account of its warping, but chiefly by reason of the resin which was found in most Australian woods, and he might mention that in North Borneo there was no lack of wood suitable for this purpose. The best forests were very near the harbours, and all that was required was a moderate amount of capital. An interesting lecture had been delivered in that room on the previous evening on the merits of iron as a building material, and the danger which arose from its rusting, and it really seemed a question whether some of these hard woods might not advantageously replace it for many purposes. He thought all the Colonies were much indebted to Mr. Ransome for what he had done in drawing attention to these valuable woods.

Mr. BOULTBEE said that having had upwards of twelve years' experience of the timbers of the Straits Settlements, in saw mills, and with wood-working machines generally, for converting the same, he desired to make a few comments on this exhaustive paper. The thanks of all Colonists were due to Mr. Ransome for having brought forward this most important subject, and for having thrown such an interesting light upon it by publishing the results of the experiments with the various woods indigenous to each country, that had apparently been so carefully conducted by his firm. The timber trade in the far East, and by this he meant particularly the Straits Settlements, was not now nearly so remunerative as in former years, in consequence of the jungle near the banks of rivers having been denuded of its marketable woods; but the Government of the Straits Settlements were so much alive to the scarcity of timber in the future, that a Forest Conservancy system had lately been established. Johore, the native state adjacent to Singapore, and ruled by its Sultan, was in the same plight, and the greatest difficulty was experienced now in securing a sufficient supply of wood to keep the large mills there fully employed. One of the most lucrative businesses in years past was the supply to the Indian railways of sleepers, which were of ballow, a species of greenheart, indigenous to the Johore jungle. These sleepers were sold at forty dollars per ton of fifty cubic feet, free on board; but the supply was now almost exhausted, and a suitable substitute would soon have to be found from some other country. From this it would be gathered that the timber-supplying countries he had mentioned in the far East were gradually being worked out, and it was high time for capitalists to begin looking about for fresh fields. The day could not be far distant when China would be called upon and urged, through the enlightened policy of its new Prime Minister, the Marquis Tseng, to inaugurate a railway system, and an improved public works department; and as this vast empire had little or no timber of its own, adjacent countries would be called upon to supply its deficiency. Amongst the timbers enumerated and described by Mr. Ransome, those of British North Borneo especially commended themselves to those interested in the future trade of the Eastern hemisphere, and he thought the day was not

far distant when that country, with its almost inexhaustible forests of valuable timber, suited as they were to all purposes, would be the country to which we must look for our future supply, and a glance at a map of the world showed how admirably it was situated as regards position, for the various markets that it would have to accommodate.

Sir Charles Mills, K.C.M.G., said Mr. Ransome had not alluded to one quality of the Cape yellow wood, viz., its adaptability for railway sleepers. Some of it was brought to England, and under the supervision of Sir Charles Graham and Mr. Wakefield, was creosoted, and it was found to take the creosote as well as Swedish pine; and now, even after paying the heavy cost of sending creosote to the Cape, railway sleepers were made of this material much cheaper than they could be procured from Europe. The other woods at the Cape were heavy hard woods, and he thought they might with advantage be imported here, because most of the homeward vessels from Africa and Australia were laden with wool, which being a light cargo, would enable heavy wood to be carried as ballast. One remark in the paper, that a particular kind of wood from New Zealand would be expected to be exhausted in about twenty-five years, required he thought, the most careful attention. The question of the supply of timber never ought to be discussed without considering that of replanting. In many countries, such as the Cape and Australia, there were immense grass fires, which spread for miles and destroyed all the young seedlings, leaving nothing to replace the trees which were cut down. It was not merely for the sake of the timber that this question required attention, but also as bearing on the climate, it being well known that forests produced rain, and that where they were cleared drought was apt to follow. In the Orange River Free State timber was extremely scarce, even firewood fetching £3, £4, and £5 a load. He knew a gentleman there who married rather late in life, and being rather apprehensive how he should provide for his family, he decided that whenever he had a child born, he would plant a thousand blue gum trees, which in five or six years grew up pretty high, and in twenty years were worth £6 to £8 each. He only had two daughters, but he planted a thousand gum trees at the birth of each, and when they married they each had a dowry of over £6,000 from these trees.

Mr. Walsh remarked that one of the most striking features in connection with the Colonial Exhibition was the display of timber, far beyond what most people had any idea of before. Jarrah was a very excellent timber, and was said to be impervious to the attacks of the teredo and white ant, and besides that, it had the valuable quality of being durable between wind and water, and just where it entered the ground. The great want with regard to it, and all the timber of West Australia, was capital. It was too often cut and sent into the market unseasoned, and thus did not always turn out so satisfactory as it should. The heart of the jarrah was entirely useless, and should be removed. He was astonished to hear from Mr. Ransome that it could be bought for £6 a load.

Mr. C. Dicken said that two of the Queensland timbers, the cypress pine and bean tree, were excellent, but there were also other very good timbers, the banya pine, mahogany, and others. The cedar was considered one of the best, two logs of which were shown in the Exhibition, about 20 ft. in circumference, being only fair samples of the trees growing there. He had never visited the Yarrah, but he read Mr. Froude's account of the trees there, 300 ft. or 400 ft. high, and 20 ft. in circumference, and all through Queensland he had seen magnificent timber on the mountain ranges, which it took five or six men joining hands to span round. A few weeks ago, a friend from Australia told him he had seen on the Daintree river trees as high as the houses in Victoria-street. There was an immense wealth of timber in Queensland, and it only required the market to be opened up to bring to bring it into demand. The cypress pine and bean tree made beautiful furniture, and would come in excellently both for cabin fittings and decorative purposes. The banya pine was also a good working wood; all the fittings at the Exhibition were made of it, and the workmen told him it was capital timber. There was also a kind of box, which he held was suitable for engraving purposes. They had had a report upon it from Mr. Jackson, of the *Illustrated London News*, which was on the whole very favourable, but the sample had not been properly seasoned. He might add that the collection of timber at the Exhibition had been generously given to the Imperial Institute, so that it would be always available for inspection.

Mr. D. Morris being called upon to speak on the woods of the West Indies, said Mr. Ransome had very properly confined his attention to the new woods brought forward at the Exhibition. The horse-flesh mahogany from the Bahamas was a very excellent wood, tough and enduring. The tree at the Exhibition was presented to Kew, and they were at first disinclined to take it, because they were unable to determine its botanical character; but on appealing to the Government of the Bahamas, some specimens were sent over to show that it was closely allied to the *bragiletto* wood, which was very highly esteemed in the West Indies, though it was only a small tree. The timber of British Honduras best known was mahogany, and the cedar used for cigar boxes. As in the Straits Settlements, most of the valuable timber within reach of the rivers was already cut down, but if railways were

opened into the country a large quantity could be brought down. It would be useless to import any very heavy, tough kind of timber, as there would not be a sufficient demand to make it remunerative; there were some excellent timbers in the West Indies which could be easily brought if the price offered would justify it. The paper was very valuable, as suggesting to Colonists what sort of timber to plant, in the manner pointed out by Sir Charles Mills. The yellow wood of the Cape, for instance, being applicable to so many purposes, should be developed; he had seen it growing in Saint Helena, and had introduced it into the West Indies, where it grew very well. The straight-grained cedar, which he had already referred to, was easily worked, and it might be grown in any part of the West Indies, at elevations of from 1,000 to 4,000 feet. In many of the Colonies there were extensive tracts, once occupied as sugar estates, which could very well now be planted with timber, such as the yellow wood or cedar; and there was no doubt the time was coming when re-afforesting must occupy more attention in all the Colonies. The forests were cut down, and the land used for other purposes, and when it was exhausted by cultivation, it was often left to go to bush or jungle, when it would be much better to plant timber. In different parts of the world trees could be found adapted for any waste places, some for clay, others for rocky soil, and so on, and cedar, for instance, would grow well in a limestone soil. It often happened, too, owing to the change of climate arising from cultivation, that trees from elsewhere did better than those which were originally indigenous. Australian and Cape trees did better in the West Indies than those which originally grew there.

Mr. FORD said his experience of these woods was rather limited, for when he was at the Cape the works were principally carried on with imported timber. He had seen yellow wood growing to the height of 70 ft. or 80 ft. and 5 ft. or 6 ft. in diameter, and when kept from the action of the weather it lasted a long time, some having lasted over a hundred years in the Dutch houses, being still perfectly sound, but when exposed, it decayed in a short time. Probably from this cause it was found necessary to creosote it. He had had the privilege of witnessing Mr. Ransome's experiments, and would remark that they pointed to the use of these woods by joiners and cabinet-makers, for cask making, &c. His attention had been more directed to the use of timber for engineering purposes, and he was now connected with a railway in West Australia, which was being constructed on the land grant principle. On those lands no doubt there would be a good deal of jarrah and karri, and the peculiarity of these were that they resisted the action of the teredo and other worms which so rapidly destroyed timber in salt water. At present greenheart was almost exclusively used for such purposes, and if any timber could be found to take its place there would be a large demand. Jarrah at present was on its trial; he had taken pains to collect information, but it was not quite clear and satisfactory, though it had been used largely in South Australia, Melbourne, Sydney, and Queensland. The railway company he spoke of was now constructing a large jetty at Albany with karri, which was said to be similar. The black ash of Canada seemed very remarkable in not shrinking on being dried, and it had been considered suitable for cask-making from a mechanical point of view, but he should like to know whether it would be suitable for holding wine and such liquids.

Mr. G. N. HOOPER said, as a carriage-builder, he had not had much experience of these woods, but he felt much indebted to Mr. Ransome and to the Society of Arts for initiating this discussion, which would tend more than anything else to achieve the result desired by the Colonies of finding a market for these timbers. There had been too much laxity in preparing some of the specimens sent to the Exhibition; for instance, he heard that those from Canada were collected in a short space of time, so that the necessary care could not be given to them. In 1862, being on the jury on the carriage department at the Exhibition, he had to examine woods sent from some of the Colonies, and published a list of those suitable for carriage purposes; but for twenty-five years nothing came of it. Meetings of this sort were a much more practical way of bringing the matter before manufacturers and those interested in the trade. Manufacturers required full information with regard to any new wood as to its qualities, and the proper method of seasoning, without which a good article might be unfairly condemned; they also required to know the price at which it could be delivered, and if the supply could be depended on, for it did not do to introduce a material and then have to use something else. Various new processes for seasoning timber were coming into use, and he had seen in America, at the Pullman works, a process which was then new to him, but which, he was told, was being introduced here. Large sheds were used, in which the timber was stacked and steamed for so many hours, after which it was exhausted by a fan, and hot air blown in. The result seemed very good, judging by the work turned out, which was first-rate, both in material and finish. The cold air system spoken of by Mr. Ransome seemed to succeed well, and certainly, if the period of seasoning could be curtailed, it would lead to immense economy. He could bear testimony to the excellent quality of some of the woods at the Exhibition which were worked up. Those in the South African wagons were very fine, and the workmanship was also good, and he was informed that one of those wagons had been made by Kaffirs, under English superintendence. He would also draw attention to the excessive waste of timber in some of the Colonies. He had been painfully struck by it in Canada, some

of the waste being accidental and some wilful, but the destruction of good material was most lamentable. Two Committees of the House of Commons had discussed the question of founding schools of forestry, for up to the present young men trained for the Indian Forest Department had to go to France or Germany for instruction. Much good had already been done in India in this way, and there was no reason why equally good results should not follow in England and Scotland, and especially in the Colonies, from attention being paid to the forests. He though there should be schools of three grades, one for the actual working men, one for the superintendents, and a high school for proprietors of forests and those who worked them commercially. It occurred to him that as all kinds of garden produce were improved by cultivation, so it must be with trees. Much of the timber in this country, oak, ash, and elm, was unsurpassed in quality, it being grown under conditions of semi-cultivation, whereas, in a wild forest, for every fine tree there might be 50 or 100 very inferior. If partial cultivation had been so successful, more careful cultivation would be more entirely so. After all, the most important point was to encourage the growth and import of timber from our own Colonies, in preference to depending on foreign countries, as we now did so largely.

Mr. JACKSON (Kew Gardens) was very glad to have the opportunity of recording his thanks to Mr. Ransome for allowing him the privilege of being present at some of his experiments made on the North Bornean woods. With regard to the question as to resins in wood, Mr. Ransome would remember that, when treating the maraboo, the pressure on the morticing machines apparently drove a quantity of moisture through the wood. This was of an extremely opaque red colour, and it struck him at the time that it might be some resinous substance similar to Kino, which was found in the pterocarpus and leguminous trees grown in India. He took a sample back to Kew, and by the time he got there he found the colouring matter had exuded from the wood, and deposited itself on the surface in the form of globules, and on tasting these he found them decidedly astringent. On examining the wood as it dried a few days afterwards, he found the cells were filled with resin, which indicated clearly that this wood was not far removed from the pterocarpus, and that it really contained a kind of Kino. The maraboo had been described by Mr. Baker in the "Flora of British India," but there was very little known of it botanically. There was a note in that book to the effect that Mr. Griffiths described it as a fine Malacca timber tree, which agreed a good deal with what Mr. Ransome had said. The interest of this wood was enhanced by the fact that not only was it a good timber wood, but it would be well to see if it did not yield Kino also. With regard to Russock, it appeared to belong to the natural order from which came the Sal timber of India. Unfortunately, very little was known of the botany of these various trees, and such an enormous quantity of material had been sent to Kew that they had not yet had time to examine them all, only those two he had drawn special attention to. He hoped soon to be able to clear up the character of many of these trees.

Mr. McINTYRE, as a colonist of Victoria, desired to thank Mr. Ransome for his very practical paper. Victoria had not done much in the way of timber, but she had shown some. Although the smallest Colony, it was the most active. He might also say that they were doing a good deal towards the conservation of forests there. No doubt there was too much waste in early times, more particularly in Victoria; but so fully were they now aware of the importance of the subject, that Forest Conservancy Boards had been established at very large cost, and so they had also in South Australia and New South Wales.

Mr. JOSSELYN said what struck him most as a manufacturer, and to some extent as a user of timber, was the necessity of a proper selection of timber, and treating it before it was sent to market, for a good deal came in a condition not fit for use. Up to the present the Colonists would cut down the timber without thinking much about the necessity of converting or seasoning it. They then sent over trial lots, which came to the brokers, and were put up to auction, very little being known about it, and the result was that they were disposed of at firewood prices. Even in the Exhibition itself there were many specimens which had been in some way improperly treated, either felled at the wrong season, or the heart not taken out when it should have been. It was very important that colonists should consider these questions before sending over timber.

Mr. LEWIS RANSOME then gave some particulars of practical test made on the breaking strain of some of the most important woods, which will be found on page 301. From these it appeared that billian was the best of all, not only from its durability, but from the great tensile strain which it will bear.

The CHAIRMAN, in proposing a vote of thanks to Mr. Ransome, said this paper represented an immense amount of conscientious solid work, in a matter of vast importance to England as a commercial nation. The *Eucalyptus globulus* was a timber of which supplies might be obtained from other countries besides Australia, for, as Sir Charles Mills had said, it might be properly grown in the Orange Free State. It was also largely planted in Algeria, and it had the particular merit of being a hard wood, and at the same time of very rapid growth, qualities which were seldom united; it was a timber which was

likely to have a considerable future. He remembered the time when jarrah was only a curiosity in botanical museums, but he believed one of the results of the Colonial Exhibition was to give it a marvellous impetus in the English market, though it remained to see whether it fulfilled all the conditions required of timber for engineering purposes. There was no doubt, however, that the specimens sent by Western Australia produced a profound impression, and he was glad to say that the marvellous log which every one admired so much in the Exhibition had been presented to the Museum at Kew. He had been extremely interested with what was said about kauri, though his satisfaction was dimmed by the reflection that its existence on earth as a timber tree must be regarded as limited, for although kauri could be planted, it was not likely that for many generations to come trees of such dimensions as 15 ft. in diameter could be produced. He was also interested in the Umzumbit wood of Natal, being one which they had long had under notice at Kew, and had only recently discovered its botanical belongings. He must give Mr. Ransome great credit for the pains he had taken to give the scientific names of the woods under examination. It might to some appear pedantry, but it was the only clue by which they could find in botanical books any account of the habits, geographical distribution, or peculiarities of any tree referred to. A reference to the catalogue of the Kew Museum would show that such names as pines and cypress were perfectly valueless for discrimination, and it was, therefore, necessary to fall back upon botanical names, however uncouth they might appear, for the purpose of identification. The North Bornean woods certainly afforded an immense field for enterprise, and he only wished, from a botanical point of view, that they knew more about them. They would be found probably to have many characters in common with the best Indian woods, and also with those of the Malayan Archipelago. With regard to the forest conservation, it must be remembered that, after all, what they had been discussing that evening really represented the consumption of part of the world's capital. The clothing of timber on the earth's surface was like the store of coal beneath. They could draw upon each to a large extent, and in the present generation tolerably freely, but recuperation would not take place at anything like the same rate, and the time would come when both timber and coal would become perceptibly scarcer. He was glad to find that this was already beginning to be appreciated, and that in many of the Colonies proper precautions were being taken for the conservation and the replanting of forests. He was very glad to say that at Kew they had been able to assist the Government, and that the forestry officers in India, Penang, Malacca, and Singapore, had been selected by that Department, and something had been now done to prevent the destruction of wood at the rate at which it appeared to have gone on in Johore. Nothing had been more public-spirited than the efforts made at the Cape and South Australia to organise a Forest Department, and lay out forests which, in time to come, would no doubt produce a good supply of timber.

The vote of thanks having been carried unanimously,

Mr. RANSOME, in reply, said the information he had been able to convey that evening was like a drop in the ocean compared with the great question of Colonial timber supplies. His experiments had been very limited, because he had only got very small samples of many of the woods, but he hoped that what had been done would give a start to the investigation, and that it might be followed up in a more systematic and perfect way. With regard to billian, though it was so hard as not to be pleasantly worked by hand, yet there was no difficulty in working it by properly constructed machinery, and taking it all round, it was undoubtedly the best hard wood in existence, as the figures showed it was 30 per cent. stronger than any other wood, as regards its capacity to withstand a breaking strain. Mr. Dent had expressed some surprise at the price quoted for kauri, but he could only say that at present they paid for pattern makers' pine 3s. 7d. per cubic foot, and they could buy kauri at the docks for 3s., and brokers state it would go down still lower in consequence of two or three cargoes on the way. If so, it would only be on account of the ignorance of the English people as to the value of the wood, for it was quite as as well worth 5s. as ordinary pine was worth 3s. 7d., and he would advise all who were interested to buy it while it was cheap. With regard to the upright yellow wood, it was far too valuable to be used for sleepers, but probably Sir Charles Mills referred to another description of yellow wood. Mr. Walsh thought he had put the price of jarrah wood too low at £6 a load, and he might say that that gentleman had informed him that his company could deliver it at £8. He had, however, competitors, for there were four firms in London interested in jarrah, and the price he had quoted was that at which the last lot was sold, and there was still some at the docks which was offered at that price. With regard to Queensland timber, he could endorse all that had been said by Mr. Dicken, particularly as to the magnificent cedars. He had tried a few of the Queensland woods but they came in rather late, and he was not able to get the results into the paper, but they would appear in the official report. He regretted that he had not more large samples from Queensland. Mr. Ford's query with regard to the suitability of these woods for wine casks was a most pertinent one. His experiments of course only applied to the mechanical qualities of the wood, and it was quite possible that some of these woods might not be suitable for storing wine, but at the same time such an immense variety of liquids were stored in casks that no doubt all these woods would be suitable for making casks for

some purposes. In conclusion, he desired to convey his thanks to his partners, Mr. Josselyn, his son, and also to Mr. Batch and Mr. Page, who had assisted him in conducting the experiments. All the large samples sent them had been exhausted, but if any gentleman would send over a log big enough to try, they would do their best to test it, and let them know what it was worth.

TESTS OF THE BREAKING STRAINS OF SOME COLONIAL WOODS.

Name of Wood.	Deflection at 2 cwt.	Deflection at 2 cwt. 1 qr.	Broke at	Remarks.
Billian, North Borneo	$\frac{1}{4}''$	$\frac{5}{16}'$	5 cwt. 96 lbs.	Good break, 12″ long.
Karri, Western Australia	$\frac{1}{4}''$	$\frac{5}{16}''$	4 cwt. 18 lbs.	Very fibrous but somewhat short break.
English Oak	$\frac{3}{8}''$	$\frac{7}{16}''$	3 cwt. 95 lbs.	Long fibrous break.
Teak	$\frac{3}{8}''$	$\frac{9}{16}''$	3 cwt. 67 lbs.	Short sudden break.
Yellow Deal	$\frac{3}{8}''$	$\frac{7}{16}''$	3 cwt. 50 lbs.	Good break, 6″ long.
Russock	$\frac{3}{8}''$	$\frac{13}{32}''$	3 cwt. 49 lbs.	Very fibrous break, 4″ long.
Mirabou	$\frac{1}{2}''$	$\frac{7}{16}''$	3 cwt. 46 lbs.	Good break, 7″ long.
Jarrah	$\frac{1}{2}''$	$\frac{5}{8}''$	3 cwt. 7 lbs.	Good break, 7″ long.
Kauri Pine..............	$\frac{3}{4}''$	1″	2 cwt. $67\frac{1}{2}$ lbs.	Very short break.
Serayah	$\frac{5}{8}''$	$\frac{3}{4}''$	2 cwt. 55 lbs.	Fibrous but somewhat short break.
Douglas Fir	$\frac{3}{4}''$	1″	2 cwt. 42 lbs.	Short break.
Best Pine	$1\frac{3}{8}''$		2 cwt.	Very short.

All samples were sawn from plank, planed 1″ square. Bearings 2 ft. apart.

TENTH ORDINARY MEETING.

Wednesday, February 16th, 1887; HERBERT C. SAUNDERS, Q.C., in the chair.

The following candidates were proposed for election as members of the Society:—

Bennett, James, Ruchill, Glasgow.
Grove, W. B., B.A., Queen's College, Birmingham.
Leane, George Henry, 21, Queen Anne's-gate, Westminster, S.W.
McIntosh, James, Duneevan, Oatlands-park, Weybridge, Surrey.
Marwood, David, School of Art, Halford-house, Richmond, Surrey.
Simpson, A., B.A., Constitutional Club, W.C.
Webb, Francis William, Chester-place, Crewe.

The following candidates were balloted for and duly elected members of the Society.

Ballard, William Washington, 46, Bedford-row, W.C.
Bell, Edward, 4, York-street, Covent-garden, W.C.
Drower, John Edmund, May Trees, Endlesham-road, Balham, S.W.
Hodgson, Shadworth Hollway, 45, Conduit-street, W.
Longden, John Needham, 9, Castle-street East, Oxford-street, W.
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The paper read was—

USES, OBJECTS, AND METHODS OF TECHNICAL EDUCATION IN ELEMENTARY SCHOOLS.

By HENRY H. CUNYNGHAME.

No apology is needed for bringing to the notice of a Society founded for the purpose of encouraging the arts and manufactures a subject so important as the education of our mechanics and artisans.

A generation has not yet passed away since the necessity of educating the masses of the people was recognised, and only some fifteen years have elapsed since the subject was undertaken in earnest. Though England was late to begin, as compared with foreign nations, yet her progress in this respect has been surprisingly rapid, and bids fair shortly to place her in possession of a system of schools in no way inferior to those on the continent of Europe or America.

But an opinion is steadily growing up, and every day finding more adherents, that our elementary training, whether for rich or poor, is still incomplete, and that it will not become fitted to the wants of the time until it has undergone some grave modifications. For, since the framework of our educational system was put together in the Middle Ages, great modifications have taken place in modes of thought. The criterion of truth is no longer

the voice of authority; the schoolmaster must therefore modify his system. He has no longer a right to require the assent of his pupils by a mere *ipse dixit*. His true province is now to teach his class how to observe, and how to experiment and learn of nature for themselves, rather than to supply them with an encyclopædia of facts, supported only by the voice of authority.

In the Universities this change of system is silently but rapidly progressing; science laboratories are rising up everywhere for the experimental method of study, and mathematicians, imitating the example of men like Newton, Gauss, Pascal, Clerk Maxwell, or Sir W. Thomson, are going to experiment for the basis of their theories, instead of for ever proceeding by a deductive method based upon a series of unverified assumptions. So that it is no uncommon sight to see a Senior Wrangler in the physical laboratory.

Even classics, the former stronghold of didactic teaching, is taking the same line. Visits are made to Greece, and scholarships awarded to enable Egyptologists to study upon the spot; and thus understood, classics, instead of being confined to an imitation of the styles of ancient authors, is becoming expanded over the whole field of ancient philosophy, history, and art, and therefore glows with a life, a truth, and a reality that it never previously possessed.

In the great public schools, too, the same influence is spreading; laboratories are being constructed, presided over, not as before by the nearest country medical practitioner, but by men who have regularly taken their degrees in chemistry and physics. There are botanical and entomological clubs, and in the corners of the play-ground carpenters' shops are being erected.

These shops are it is true, not yet on a satisfactory footing. Patronised with perhaps a shade of contempt by the classical master, they are often left to the mercies of some superannuated carpenter, who has never received any sort of scientific education. This neglect, perhaps, proceeds from the entire ignorance that the whole of the principles of geometry and mechanics can be learned in a carpenters' shop, with pieces of wood, nails, and string, in a manner in which they can never be acquired in the class-room.

Not for a moment is it intended here to deprecate the use of high mathematics, but, the principle of virtual velocities, or the conservation of energy is not half so vivid and real to a boy who has never gone beyond paper work as it is to one who has been allowed to construct a wooden scale beam, or been permitted to handle even a home-made gyroscope.

Little children have nearly solved the question for themselves, by refusing to learn except through the eye and hand, and for them the Kindergarten system, when properly used, serves as a method of experimental education.

Our Board schools have very properly been framed after the model of our best public schools, and will, therefore, probably have to follow in their wake. For if some sort of experiment has been found beneficial in the case of those who are to follow learned professions, how much more valuable must it be to the artisan?

Moreover, other influences are at work making the need of it still more imperative. Up to the present century industries were secrets, they were the property of cliques and classes, they were mostly carried on on a small scale, and the workmen, as well as the industries, were localised in centres, often fixed for them by political considerations, but from which it was very difficult to move. But printing has almost destroyed the secrets of industries. The growth of ideas is destroying trade corporations and privileges. The invention of machinery has diminished small factories; and the railway, while it has increased the localisation of various trades, has enabled the population of artisans to flow freely from one place to another. And thus, in less than a century, the whole industrial system of the country has been revolutionised and reconstructed.

This reconstruction has its good and bad sides, Manufactured articles of all kinds are incredibly cheaper than they used to be (regard being had to the change in value of the money-standard). Moreover, there is, for all who choose, far greater chance to enter the class of skilled artisans. But, on the other hand, the mechanic is kept week after week, and year after year, at the same monotonous employment; and specialisation of labour pushed over-far tends to the degradation of the workman, and the diminution of the art-value of his work.

This evil produces the result that although the entry into any trade is more easily open to a mechanic, yet education in his craft becomes more and more difficult, and it becomes more and more hard for him to "rise from the ranks;" and in all trades in which individual skill, adaptability, and thought are

required, complaints are increasing that the skilled workman will soon disappear.

Under the old system, apprenticeship was the only road to learn a trade. A picture of it has been preserved to us by the pencil of Hogarth. The apprentice paid a fee for instruction, aud received his board and lodging as an equivalent for his work. If idle, his master corrected him; if he ran away, his chance of employment elsewhere was very small. The master who took an apprentice, often gained a friend, a future partner, and perhaps a son-in-law. There was then every inducement for a master to teach his apprentice, and accordingly apprentices were carefully instructed. There were abundant numbers of good artificers in proportion to the demand for their work. The old watches of 100 years ago show such exquisite taste and skill in the mere embellishment of the interior, that the balance-spring covers were models of art-engraving. Thousands of those old watches have been recently broken up in order to turn these covers into ladies' necklaces, the brass being covered with a thick coat of electro-gilding, a fact which reflects anything but credit upon the state of the jeweller's art at present.

The apprenticeship system is now on the decline; this is due to three causes. In the first place, the apprentice rarely boards with his master—the factory system has rendered that impossible, and increased means of locomotion have raised the number of apprentices who live with their parents. In the next place, society is now so large, and trades are so scattered, that an apprentice can easily run away from one master and enter the service of another; so that it is hardly worth while for a master to expend pains in teaching him his trade. Moreover, the factory system creates a demand for half-educated lads, and by offering wages which appear high to boys of eighteen, induces them to leave their masters just when they are learning most, and on the way to become accomplished masters of their craft. The result is, that formal indentures are now becoming rarer, and boys generally commence to learn a business by entering a shop at 5s. a week, which is an insufficient equivalent for the board and lodging that was once afforded them.

There are other causes which also operate in the same direction. In the factory no provision is made for teaching; the master chiefly desires human machines. If he develops skill in a boy, he will soon be met with a demand for higher wages, or a threat to leave and carry away some of the secrets of the workshop. It is, therefore, rarely the interest of masters to do much towards teaching apprentices.

On the other hand, the men have a direct interest in doing still less; for each apprentice, when taught, becomes a rival, whose competition aids in lowering wages. Therefore, we find that trades' unions and societies, so far from facilitating the teaching of apprentices, frequently try and limit their numbers.

The sole idea of parents is too often to get the boy to bring home as much money as he can to help the household, and consequently when the question arises whether he shall go on at a low wage in the place where he is really learning, or leave it in order to obtain a higher wage at a place where his instruction will no longer be progressive, every home influence is exerted to induce him to take the latter course, to the ruin of his career as a skilled artisan. And, lastly, the boy himself has rarely, at the age of 19 or 20, sufficient judgment to resist the alluring prospect of earning 20s. or 25s. a week, and being enabled to marry and have a home of his own.

It is easier to point out these difficulties than to see how they are to be remedied. In part, no doubt, they will remedy themselves; for every year the industries of Great Britain take a more artistic direction. But true artistic work can never be done by machinery. The greater part of the subtle charm which an artistic object presents is the impress of the mind of the artist. This tendency, then, of the industry of England to develop in an artistic direction can hardly fail to be of benefit to the artisan.

But still, comparing the immense relative progress made by France and Germany in the art and industrial education of their workmen with the slower progress of England in that direction, there can be no doubt that much requires to be done in this country. Moreover, an inquiry into the causes of the great increase of manufactures on the Continent during the last half century will show that this increase has been, to a considerable extent, due to good artisan education, and will prove that money expended upon technical education will be a profitable investment.

When once it has been decided that technical education is needful for the artisan, it becomes at once important to determine what the nature of it shall be; for, after distinguishing it from purely literary or scientific or art education, it may still be either of a theoretical

or practical kind. It may merely endeavour to teach the workman how to apply scientific principles in the execution of his work, or else it may go far beyond this, and endeavour to educate him in manual dexterity. Now, for each of these two kinds of technical teaching there is a proper place. The technical school is the place to learn the application of theoretical and scientific principles to industry, but technical dexterity can only be acquired in the workshop; and the boundary of them not being always very easy to define, all the more care is needed that neither of these shall include on the functions of the other.

There is little danger that the workshop will ever become too theoretical, but there is great danger that the technical school may entirely miss its mark, by stepping out of its proper position and trying to become a workshop; and there is also great danger that the attractions of the technical school may blind us to the fact that no technical school can ever efficiently replace the workshop.

The barrister is formed at the Law Courts and in chambers, not in the lecture-room; the doctor by walking the hospitals, not in the study; and the engineer and mechanic must follow the course. For the generality of men trained purely in the laboratory will never learn to deal with the difficulties of life in the world of practice so well as those who have been brought up face to face with it.

Moreover, it must be remembered that no technical school can possibly acquire all the plant and machinery necessary to teach various trades, and to keep constantly up to date in improvement, and, further, that even if it could, it is impossible to see how a whole population of boys could be fed and clothed while they were learning. For the parents could not support them, and as trade concerns technical schools can never be made to pay.

If their views be correct, it follows that the apprenticeship school is to be condemned, and that all technical teaching should be carefully relegated to its true sphere, that of methodising and systematising practice, of teaching the reasons for empirical rules, and showing how to reach new ones by skilful inference.

The object of technical school instruction should be not to make workmen but to prepare men to become workmen, and thus understood, it will at once elevate the mind, and improve the wage-earning capacity of the artisan.

This truth is generally recognised in Germany and in England, but in France a contrary opinion prevails, and apprenticeship schools have been established there which cost the most fabulous sums to maintain, and which in no way return an equivalent for the money spent upon them. We, therefore, require a number of theoretical technical schools, well equipped and adapted for boys and men of all ages from about 14 upwards. To these schools those will go who can afford to spend some years without earning their bread, and to those schools also will go the cleverer boys who are fortunate enough to win scholarships. But in addition to this school-course they will, if their parents are wise, also go thoroughly through the workshop. They may, as is done in Scotland, spend the summer at the workshop and the winter in the school, or they may take two or three years of one, and then spend some time at the other.

But for the mass of artisans, at least unless Socialism is to come into force, this long course at day technical schools will be impossible. They have to earn their bread, even at 14; their parents cannot afford to support them, and, therefore, if elaborate day schools are provided for them, the result is that these schools will gradually tend upwards, and become the property of the richer classes. It is no use providing for the artisan what he cannot make use of, and you cannot give scholarships for every boy in the whole nation.

This, then, brings us to the two things that we can do. We can at least prepare them in some degree in the elementary schools; we can provide them with evening classes during their apprenticeship years, and we can do all in our power to persuade masters and boys to take advantage of these advantages.

I propose to consider what method is the best to adopt in the elementary schools. What we want, is to prepare an artisan for his work. Now, after arithmetic, the five sciences which are probably most useful to the artisan are geometry, algebra, mechanics, physics, and chemistry. For instance, the making of a clock brings in simple geometry, algebra, and mechanics; a steam-engine requires these, and some knowledge of physics also; while a gas-engine demands an elementary acquaintance with all of them.

Now, as the first of these I have placed geometry. And I specially desire to include in this the art of looking at a thing, and then being able to remember how it was put together, to make a sketch of it, and to be able to show

anyone how to make one like it; and the converse, of being able to see a picture of a thing, and then make the thing from the picture.

As an example of how much instruction is required in what appears so simple, I here exhibit five little clay models; they were done by five children (of from 9 to 11 years of age) selected at random, and quite without any previous training in form, and executed from the drawing that you see of a pyramid. You will notice that there is no idea in their minds of the sharp edges of the pyramid. They have made pear-shaped cones. This shows at once how much they need instruction.

Therefore it is here suggested that the elements of geometrical drawing should be taught in the elementary schools, using rulers and compasses, and closely in connection with a carpentry class. The course should not go far, but be thorough, and should include the principal properties of the straight line and circle. Repeated practice should be given in making drawings upside down, reversed, and of different dimensions. (It will be found that very many boys who can do a given problem in Euclid cannot do it if the figure is turned upside down.) The figures should be drawn out neatly with ruler and compasses; and elementary proof should be given, depending generally merely on symmetry and proportion. The strict logic of Euclid is best reserved till the faculties are more developed. Splendid as is the training, it is too severe for boys of eleven and twelve, and rather retards than advances them in the subject.

Contemporaneously with the geometry class there should be a carpentry class; two lessons of two hours each a week is not at all too much to devote to this purpose. Short lectures should be given on the nature of woods and the use of tools, which should be introduced in proper order; first the saw, then the chisel, and then the plane. But all objects should be made to scale and measurement, and, if possible, little drawings of them made in a book, serving as practice in drawing and a record of progress. Then the jack and trying planes should be introduced, and the boys taught the principles of making rectangular blocks of substances, the rules for which are of course the same for wood, stone, or metal; the tests to show whether a surface is true or skew-shaped, &c., should be explained.

The boys may then go through a simple series of joints, such as are here shown, in drawing, and made up. But with all this, it must be remembered that it is just as easy to do unprofitable hand work as unprofitable head work, and that technical education badly conducted may become more "mechanical" and stupefying than the worst conducted book lesson.

The above instructions will probably be sufficient for most boys up to the time they leave the Board school.

The girls, and perhaps some boys, may be treated perhaps more on the artistic side. Instead of geometrical drawing and construction, they might be taught freehand drawing and modelling. I here exhibit a collection of work of a class of little girls at St. Jude's School, Whitechapel. It is not a good plan to place the work to be modelled on a flat table; it should be inclined at a steep angle like a desk, and the design to be copied placed sloping forward above it, so that the planes of both are about perpendicular to lines drawn from the eye to their respective centres. The good arrangement of light is also important. Stone, wood, or metal work depends on cutting a form out; modelling depends on building up. Hence the procedure in these arts is fundamentally different, a fact which should not be lost sight of.

We, lastly, come to the question of cost. The annexed list is arrayed for a class of thirty boys, there being supposed to be 300 in the school, of whom 150 had two lessons of carpentry each week. The set of drawing instruments here exhibited has been found to answer very well, and costs, complete, three shillings.

The best form of bench, I think, is with an iron bench-screw. It is found in the French schools that the boys spoil wooden ones. Tools in carpentry may be divided into three classes:—1. Necessary tools; 2. Difficulty-saving tools; 3. Labour-saving tools. An example of the second is, for instance, the "valet," and the mortising chisel. An example of the third is the mortising machine. It is obvious that the beginners should be furnished with the two first of these classes as much as possible, but not with the last. They should learn to sharpen their own tools.

To fit up a room with thirty benches and iron screws would cost about £30, and therefore, adding £1 10s. a head for tools, we have £75 as the price of outfit for the school, including wood. The yearly salary of the teacher would be about the same as the salary of School Board masters. It is earnestly to be hoped that attempts will not be made to

introduce turning, or ironwork, into the schools, it only distracts the attention of the boys, renders the class much more difficult to teach, and ends by spoiling the courses of instruction. It will be quite enough if the boys learn to make a few joints thoroughly, and to do their geometrical drawing fairly well. And so also wood-carving and fancy work should be forbidden during school hours.

For the modelling for 30 children, we need—5 cwt. of clay, 30 desks, 30 modelling tools, 30 boards for clay, a selection of copies. The cost of this will be about £12.

I have thus endeavoured to investigate the uses, objects, and cost of technical education in the Board schools, and it seems to me that these and other considerations, which will doubtless occur to the many gentlemen in the room of far more experience than myself in these matters, abundantly show that technical education in the Board schools may not only be made most beneficial to the children, but that this may be done at a cost that need in no way alarm the ratepayer, provided that the system is conducted with economy, and under due direction and limitation.

List of Tools Required for an Elementary School for 30 Boys in a Class.

No.	Name.	Price each.	Totals.
		s. d.	£ s. d.
30	12-in. rules	0 1	0 2 6
30	Gauges	0 7	17 6
3	Compasses (5-in.)	0 9	0 2 3
3 doz.	Pencils	9d. per doz.	0 2 3
	Nails (various)	...	0 4 6
	Screws ,,	...	0 2 0
30	Protractors	0 6	0 15 0
30	Awls	3/- per doz.	0 4 6
30	Gimlets	3/6 per doz.	0 5 3
6	Pincers	1 2	0 7 0
30	Iron wedges	1 0	1 10 0
30	Chisels (⅞-in.)	10/- per doz.	1 5 0
30	Chisels (⅜-in.)	8/- per doz.	1 0 0
15	Socket morticing chisels (¼-in.)	1 6	1 2 6
15	,, ,, ,, (½-in.)	1 10	1 7 6
30	Gouges (3 sizes)	11/- per doz.	1 7 6
30	Jack planes (14-in.)	4 8	7 0 0
30	Trying planes (20-in)	5 6	8 5 0
1	Grindstone	...	2 0 0
1	Axe	...	0 2 6
6	Hones (with case)	4 0	1 4 0
2	Oil-cans	0 6	0 1 0
4	Quires sandpaper	0 6	0 2 0
1 lb.	Glue	...	0 0 10
1	Gluepot and brush	...	0 2 6
½	Standard of wood	...	5 0 0
1	Broom and some brushes	...	0 5 0
1	Spirit level	...	0 2 6
6	Screw-drivers	1 6	0 9 0
6	Rasps	0 7	0 3 6
30	Hand saws (22-in.)	5 0	7 10 0
30	Tenon saws (10-in.)	5 0	7 10 0
30	Exeter hammers (No. 4)	1 6	2 0 0
30	Mallets (5-in.)	1 3	1 17 6
30	Squares	2 6	3 15 0
			£58 5 7

Less an average of 20 per cent. discount for cash gives £46 12s., or £1 10s. 9d. per head.

DISCUSSION.

Sir Philip Magnus said he could do little more than assent to the propositions so clearly enunciated by Mr. Cunynghame, who had had considerable opportunities of investigating the system of technical instruction adopted in this country and also on the Continent, and had recently spent several weeks in a close examination of the technical schools in France. Mr. Cunynghame had criticised somewhat severely the apprenticeship schools of Paris, and he should be sorry to say that they were doing al that their promoters originally intended; but it must be acknowledged that they were very useful experiments, and he could not agree with the unqualified condemnation which had been passed upon them, for his experience showed him that there were exceptional circumstances under which such schools might be of considerable value—for instance, in the creation of a new industry, such as occurred in the introduction of weaving into Belgium, and as might happen in the introduction of new industries into Ireland, where they were much wanted. Again, where owing to the introduction of machinery skilled workmen became less and less competent, and where it was desired to encourage hand work, such schools might be of value, as well as in nursing an industry which required fostering and encouragement. Again, Mr. Cunynghame said that scholarships could not be provided for all boys, which was quite true, and no one suggested such a thing; but it would be a very great advantage to have schools of a grade above the elementary, into which clever intellects from those schools might be drafted. It was extremely important to pass the children from elementary schools through a sieve, if he might use the phrase, dismissing at once to the workshops those promising no special ability, intellectual or manual; but where there was a boy of superior faculties he should be able to obtain the highest education possible, so that the nation might have the advantage of those faculties being utilised to the best effect, and that every spark of genius which could be found amongst the Board school children should be made the most of. On the main portion of the paper he agreed with Mr. Cunynghame, and might say that where the handicraft system had been introduced—at St. Luke's,

Norwood, and also in a small school in Hanway-street and Beethoven-street—under favourable circumstances it had succeeded. But it was not always tried under favourable circumstances. It was very important that the handicraft instruction should be accompanied by scientific teaching, especially geometry, and where it was left in the hands of an untrained tradesman, it did not yield the intellectual discipline which was intended. It was because carpenters were employed as teachers in the Paris schools that the results had not been as good as they otherwise would have been. For this reason the City Guilds Institute was trying the experiment of educating the school teachers of elementary schools. The system adopted was in some respects conformable to that which had a wide extension in Sweden, and was known as the Slojd system, the meaning of which he could not exactly explain. One of the principles was that the instruction should be given by the trained teacher of the school; and this plan would, he hoped, be followed if handicraft instruction were included in the curriculum recognised by the Education Department. Another principle of the Slojd system was that children should do their work with as few tools as possible, and construct useful articles which might be employed in their own homes, each child making the whole article, so as to correct the evil tendencies of too much subdivision of labour. It should always be recognised that the construction of articles should be subordinate to instruction in the manipulation of tools; and that, he believed, was the principle followed by Professor Unwin at the Central Institution of the City and Guilds Institute. One of the most important things to be taught was drawing, both freehand and linear, in which we were much behind the Continental nations, where it was obligatory, whereas at present not more than 25 per cent. of children in elementary schools learnt drawing, and they were mostly under the jurisdiction of the London School Board. He would not suggest that technical schools should be established in the same style as in France and Switzerland, where the rooms were fitted up with models of the most expensive kind; and he would impress on all persons interested in science education not to try to teach specific sciences in elementary schools, but rather to give rudimentary instruction in the methods of science, so as to enable the children hereafter to take advantage of the science instruction they might obtain. It should be rather a development of the was object lessons given in the Kinder-garten. There nothing an Englishman feared more than the introduction of new subjects into education which were likely to tax his pocket, and it was very satisfactory, therefore, to know that this practical teaching was not likely to increase the School Board rate. If the subject were taught by ordinary teachers, the cost would be either nothing at all or very little. The subject was now being considered by the Royal Commission on the Education Acts, and the dissemination of such papers as this would do much towards educating the members of that Commission to appreciate the importance of making the teaching in Board schools more practical.

Mr. ENDEAN, whilst fully appreciating the importance of placing the children of England in as good a position educationally as those on the Continent, feared the matter would be much more costly than was anticipated, and deprecated any further burden being thrown on the ratepayers; any extra expenditure required for technical education should, he thought, be provided from Imperial taxation.

Professor UNWIN, F.R.S., said his acquaintance with this important subject was of very recent date, and when first it was proposed to introduce technical education into elementary schools, he thought it not at all desirable, because knowing something of the time and discipline required to make a good workman, he did not think either would be available in elementary schools. But the whole difficulty arose from an error in nomenclature; he was sorry the word technical education was used at all; it would be wiser to keep that for the application of scientific principles to manufacture, and to call what was here proposed handicraft, or, better still, manual instruction. It was important that all boys should be taught to use their hands and their eyes, and to get a knowledge of the feel of materials. The first part of the paper dealt with technical instruction really, and though he agreed with it generally, there were some points on which he should like to reserve his approval, or make qualifications. With regard to the apprenticeship schools of Paris, though the cost to the ratepayers might be about £74 per annum for each boy—and thus it would be impossible to apply such a system to all the workmen of Paris—yet it might be very useful to educate a limited number of workmen to a much higher standard than the ordinary, because the education thus given would not be confined to those pupils themselves, but would be disseminated throughout the whole industry with which they were connected. They would be centres of education to their fellow-workmen, and if the education given was good enough, the money might be very well spent. The same principle applied to all technical schools. Passing to the other part of the paper, he might say that he had now had some experience in handicraft classes, and was extremely pleased with what had been done. At present, only working in wood was taught; but he would strongly insist on the importance of adding drawing, particularly the kind used in engineering and building construction, which was entirely distinct from freehand, and had nothing in common with it. He believed that no part of a country was so valuable as its citizens, and therefore anything which improved their quality must be of first-rate importance.

Mr. W. ANDERSON said he took a great interest in

technical education, but he could not endorse all the sentiments of Mr. Cunynghame until certain alterations were made in the system as now carried out under the Department. The first thing to do was to sweep away our barbarous system of weights and measures, which took up much more time than almost any other subject, and on which the inspectors seemed to delight in torturing the children. He also thought Mr. Cunynghame had underrated the cost, not having allowed anything for the building, which, for a school of 300, would probably cost £500, apart from the land. On this ground alone it would be very hard on the ratepayers to have to provide even such appliances as were proposed. He also failed to see why the training should be confined to wood-work, which was much less important in this country than many other things.

Dr. Gladstone, F.R.S., agreed so entirely with Mr. Cunynghame, that he would confine himself mainly to stating what was being done in the direction he had pointed out. The paper had referred to elementary schools only, but the word technical was ambiguous, and had frightened many people who would have supported the same thing under another name. They did not want to teach trades, but to give the children that training of the mind and senses which would enable them afterwards to learn easily whatever trade they might practice. When specimens such as those on the table were exhibited, he had known people look at them, and say the workmanship was not good, and if they could not show better, it was not worth doing. He said, on the contrary, if there were better results it would not be worth doing. They did not want to make the boys into skilled artisans, but to give them power and accuracy of eye and hand. He should prefer to drop the word technical altogether, and speak of handicraft, or manual training, or the use of tools. What was being done in the best Board schools was this. First, the little children were taught, by the kinder-garten exercises, the use of their fingers and senses, and then by object-lessons, which were now encouraged. They were thus taught to observe and draw inferences. The same kind of lessons should also be given in the higher departments of the school, where they might come under the name of elementary science, though object-lessons would be a better title. The most important thing which was insisted upon in all Board schools for boys, was drawing; it should commence along with writing, and if modelling were added, so much the better. This was done in some schools in Battersea and other parts of London on a small scale, and would, no doubt, come more and more into use. With regard to science teaching, he thoroughly agreed with what had been said, that it was the fundamental notions of all science, rather than any one science in particular, which should be taught; not anything ending in "ology," but such a knowledge of natural laws, forces, and objects, as would be useful to every man and woman. In London, what was generally taught was Mechanics, as it was called in the Code in the fourth schedule, but on a broad basis, and the fundamental chemical facts of physics and chemistry should also be included. These could not generally be taught by the ordinary teachers, but they had followed the plan adopted in Liverpool, Birmingham, and elsewhere, of having a peripatetic teacher, who visited about twenty schools in turn, giving the same lessons in each once a fortnight, and having a good set of apparatus and diagrams. One teacher had been so employed about eighteen months very successfully, and last Thursday, after an interesting discussion, it was decided by a majority of about two to one, to add three more of these travelling teachers. They were also endeavouring to introduce the Swedish system, and in the Beethoven-street school there was instruction in carpentry. It was carried on in a sort of lean-to in the playground, on two afternoons in the week, not by a skilled teacher, as it should be, but by an intelligent carpenter, and was very popular with the boys, all of the Seventh or ex-Seventh Standard, and also with the parents. It was allowed as a reward for good conduct and attendance, and the boys much prized the privilege. They had done still better in Birmingham, where the teaching was carried on in a separate building, and more attention was paid to drawing; everything was done from drawings, which were made by the children themselves. The rules of the Department at present created difficulties, and in London the expenses had been surcharged. They had not spent £600 or anything like it—only £80; nor was the expense of the tools very extraordinary at Beethoven-street—only £6, the whole thing being merely experimental. At present they were waiting to see whether the Department would allow it to be continued, and the Rev. William Campbell, inspector for Chelsea, told him it would be allowed as a specific subject, but they did not want to take it as such, since in that school it would be necessary to give up something else in its place; it might also be introduced as an extra subject with the permission of the inspector, and probably that would be done if they were not allowed to introduce it in any other way. The desire to introduce this kind of sensible education was much more marked in the present School Board for London than in any previous Board, and in that respect it only represented the general feeling, and he felt sure that in some way, either by the Department or by Parliament, this kind of instruction would be introduced into the ordinary systematic teaching of the country.

Captain Probyn fully endorsed the remarks of Dr. Gladstone, and added that he should also like to see home industries taught, independent of technical education proper, as it would contribute materially to the social welfare of the people. He referred to spinning, knitting, and simple things of that kind. He did not quite agree with Mr. Cunynghame as to

apprenticeship, having seen the value of it in many cases. It produced better workmen and made better citizens, owing to the discipline involved. The half-time system would also commend itself to the minds of many. He thought the charge for technical education should fall on imperial taxation, not on the local rates.

Professor AYRTON, F.R.S., said there was no doubt the experimental system, which was naturally adopted by all children trying and finding out for themselves, was the best; but ordinary school subjects, such as geography and history, could not be taught in that way, but became a mere exercise of memory. He liked Euclid extremely when he studied it, but it was not a proper study for an ordinary schoolboy. You had to begin by not knowing what you did know, and only assuming a very little, you had to prove all the rest by that. A boy resented this, because he did not want to prove in a roundabout way what he was already certain of. Therefore, though valuable as an exercise of the logical power, it was totally unsuited for elementary schools. The last time he was in that room, there was a paper read on the apprentice schools of France, in which the writer endeavoured to show their great value, and specimens were shown, but practical men who examined them said they were not only badly finished, but were constructed on wrong methods; and the conclusion at which he then arrived, and to which he still adhered, was that, if that was the result, they did not want such schools in England. No doubt there were cases where such schools would be valuable. There was one in Clerkenwell, the Horological Institute. So long as watches were made by hand, as they were in this country, that was very useful; but if they were made, as in America, by machinery, it was questionable whether even that form of school would be of much value. The teachers in these French schools were, he understood, practical carpenters, and if so, it was curious that English workmen should condemn the results in the way he had mentioned. With regard to the main part of the paper, dealing with what had been called handicraft teaching, or working in wood, it was a most interesting experiment, and was no doubt better than the teaching of history and geography; but he was not quite certain that it would not have to be replaced ultimately by something still better. The main value of it was to teach boys reasoning, and that was why it was so much better that it should be entrusted to a school teacher than to a much more accomplished carpenter. But it was a question whether some elementary physics might not be better still. It was a matter of experiment, and the results should be carefully watched. Many people were apt to think that what they did not know themselves was particularly valuable. The majority did not learn to work in wood, and naturally they might estimate the importance of this knowledge too highly, just as those who had not been to a university were very anxious to send their sons to Oxford or Cambridge, whilst those who had been sometimes preferred what they thought a more practical education. The question of masters giving their apprentices or men time to acquire technical instruction was very important, and they should be led to realise how important it was for the whole country, and thus to themselves indirectly, that such facilities should be afforded. The fact did not seem to be put forward, but a great deal of technical education on the Continent was given on Sundays. This of course was impossible here, and, therefore, employers should give their workmen time, especially the younger ones, to obtain it during the week. Mr. Cunynghame naturally deplored the result of the subdivision of labour, men being occupied for their whole lives in stamping out a piece of brass always of the same shape, but possibly this was only a transition state, and when machinery became more perfect, many of these monotonous occupations would disappear, and the workmen would have to be intelligent human beings.

Mr. H. HINTON said he had had no experience of School Board boys, but at a public school he had organised a workshop system, and found it produce an immense improvement in the appreciation of mathematics and science. The study of projections was particularly useful in class work; it made a boy think for the first time, and seeing what a drawing meant in the solid was the beginning of mathematical intuition. De Morgan had pointed out the importance of counting as a mathematical operation, and the placing and counting of cubes formed an analogue to this in geometry. Definite space properties were the foundation of all science, and such fundamental facts only should be approached in elementary schools. A little familiarity with practical work would form a better introduction to mathematics than any amount of symbolical work.

Mr. G. N. HOOPER remarked on the great progress which had been made in this subject since last it was discussed in that room. It was brought before the Associated Chambers of Commerce last July, when not only the London and Provincial but also the Indian and Colonial Chambers were included, and a resolution in favour of it was then carried unanimously. On December 9th, again, the London Chamber of Commerce passed a resolution that a representative committee should be appointed to consider a well-devised scheme for improving the technical education, and last week at a meeting of the Associated Chambers the question was brought forward by five important Chambers, and again the resolution was carried by a unanimous vote. By this constant discussion they were beginning to find out what was wanted, and if, as was said, a great deal of money had been wasted on the Continent, we in England should be able to profit by their

experience as they had by ours in regard to railways, and avoid the errors they had fallen into. There were some occupations in which the teaching might be grouped, and others where special teachers would be required. It would be a great thing if when classes were started they were helped over their initial difficulties by the loan of rooms in the evenings, which might be accorded by School Boards.

The CHAIRMAN said a discussion on the School Board rate was rather outside the scope of the paper; but as the subject had been mentioned, he might say that he believed that instruction of this kind would not, for a long time at least, increase the rates, because the public had first to be instructed before they would be willing to be rated, and a rate could not be made without the consent of the ratepayers. The City Guilds were quite alive to the moral necessity they were under to do something in the way of providing technical instruction for the young men of the country, as they had proved by founding the City and Guilds Institute, and by bringing down the instruction to the school children of the country. He and his colleagues of the City and Guilds Institute were now giving their best attention to the particular mode by which the instruction might best be given; the object being settled, he thought he should by coming there learn something which would be useful with regard to this question, and he had not been disappointed. They were about to prepare a scheme in conjunction with the School Board for London, who would lend their schools for evening classes for instructing boys, and preparatory to that, classes had been formed for teaching the School Board teachers, so that there might be no lack of trained instructors whenever the public demanded this teaching for the whole of the children in the Board schools of London. He also hoped that, apart from the City Guilds, certain charities might come forward and provide funds for this great object. He was also a member of another trust which now had the subject under consideration. Beyond the commercial aspect of this system, there was the moral and social aspect, equally, if not more important, for anything which helped to interest children in education taught them the dignity of labour, and formed a kind of continuation of the school would be most valuable, and he believed this kind of instruction would be more important for those who had left school, and where able to attend evening classes, than to the elementary school itself. The Recreative Evening Classes Association with which he was connected was doing something in this way, though the instruction was not of that definitely valuable character which had been described by Mr. Cunynghame, but the two together would, he hoped, gradually train the youth of the country to occupy their evenings in a way which would not only be interesting and pleasant at the time, but useful to them in after life. There was always a fear of teaching children trades in school, and this should be guarded against. The real object might be well illustrated by an analogy which had already been employed. It was said that a lawyer was made in the Courts, and not in the lecture-room, which was quite true, but on the other hand, it was a most valuable training for the future barrister to take part, as a boy, in debating classes; he there learned to use his voice, and to put his thoughts into appropriate language, and this would be useful to him, not only as a barrister, but in many other relations of life. It would be absurd to train boys to argue points of law, however, and it was equally undesirable to teach them to be carpenters or any other trade. In these days of colonisation, it was especially important that every boy should be able to turn his hand to the various useful operations necessary in every house, without which no one could become a useful colonist. He concluded by proposing a hearty vote of thanks to Mr. Cunynghame.

The resolution having been carried unanimously,

Mr. CUNYNGHAME said he would, at that late hour, only reply to the remark of Mr. Anderson as to the cost of this system. He did not make any provision for building, because in a school for 300 children, if one room were set aside for a carpenters' shop, which would be constantly occupied by, say, thirty boys in succession from the different classes, each set having two half days a week, there would be a corresponding saving of room elsewhere, and no expense for building was required. He might state, in conclusion, that a Bill was about to be introduced, which would be supported by Sir Lyon Playfair, making it lawful to teach this subject in Board schools.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 23.—"Recent Advances in Sewing Machinery." By JOHN W. URQUHART. W. ANDERSON, M.Inst.C.E., will preside.

MARCH 2.—"The Cultivation of Tobacco in England." By E. J. BEALE. Sir EDWARD BIRKBECK, Bart., M.P., will preside.

MARCH 9.—"Railway Brakes." By WILLIAM P. MARSHALL. Sir FREDERICK BRAMWELL, F.R.S., will preside.

MARCH 16.—"Machinery and Appliances used on the Stage." By PERCY FITZGERALD.

MARCH 23.—"The Living Organisms of the Air; the Effect of Place and Climate on their Prevalence." By Dr. PERCY FRANKLAND. Professor BURDON SANDERSON, M.D., F.R.S., will preside.

Indian Section.

Friday evenings, at Eight o'clock:—

February 25.—"New Markets and Extension of Railways in India and Burmah." By Holt S. Hallett, F.R.G.S. J. M. Maclean, M.P., will preside.

March 4.—"Our Trade Routes to the East." By Major-General Sir F. J. Goldsmid, K.C.S.I., C.B.

March 25.—"Indian Coffee." By Frederick Clifford.

April 29.—"Village Communities in India." By J. F. Hewitt.

May 27.—"Indian Tea." By Dr. T. Berry White. H. S. King, M.P., will preside.

Foreign and Colonial Section.

Tuesday evenings, at Eight o'clock:—

March 1.—"The Colonial and Indian Exhibition." By Edward Cunliffe-Owen, C.M.G.

March 29.—

April 19.—"South Africa." By Major-General Sir Charles Warren, G.C.M.G.

May 17.—

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

February 22.—"Wrought Ironwork." By J. Starkie Gardner, F.G.S. Edward J. Poynter, R.A., will preside.

Cantor Lectures.

The Third Course will be on "Building Materials." By W. Y. Dent, F.C.S., F.I.C. Four Lectures.

Lecture II.—February 21.—Description of the various limestones used as building stones.—Methods of testing the quality of stone.—The preservation of stone.—Artificial stone.—Terra cotta.—Firebricks.

Lecture III.—February 28.—Lime.—Kilns used in the calcination of limestone.—Mortar.—Cements.—Manufacture of Portland cement.—Utilisation of blast-furnace slag.—Plaster of Paris.

Lecture IV.—March 7.—Asphalt described.—Timber: causes which promote its decay.—Methods adopted for its preservation.—Description of the creosoting process.—Painting.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Y. Dent, "Building Materials." (Lecture II.)
Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W., 4 p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Prof. T. McK. Hughes, "Caves; their Age, Origin, and Age of Deposit."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. R. F. Horton, "William the Silent."

Tuesday, Feb. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. J. Starkie Gardner, "Wrought Ironwork."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture VI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. William Willcocks, "Irrigation in Lower Egypt."
Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Prof. Ferrier, "The Functional Topography of the Brain." 2. Mr. H. D. Rolleston, "Description of the Cerebral Hemispheres of an Adult Australian Male." 3. Mr. Sören Hansen, "A Fossil Human Skull from Lagoa Santa, Brazil."

Wednesday, Feb. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John W. Urquhart, "Recent Advances in Sewing Machinery."
Geological, Burlington-house, W., 8 p.m. 1. Mr. Clement Reid, "The Origin of dry Chalk Valleys and of Coombe Rock." 2. Mr. James Radcliffe, "Quartzite Boulders and Grooves in the Roger Mine of Dukinfield." 3. Mr. W. F. Stanley, "Probable amount of former Glaciation of Norway, as demonstrated by the present condition of Rocks upon and near the Western Coast."
Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

Thursday, Feb. 24...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Harold B. Dixon, "The Lighthouse Experiments at the South Foreland."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Edmund Gosse, "The Critics of the Age of Anne."
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on Prof. Silvanus P. Thompson's paper, "Telephonic Investigations."

Friday, Feb. 25...SOCIETY OF ARTS, John-street, W.C., 8 p.m. (Indian Section.) Mr. Holt S. Hallett, "New Markets and Extension of Railways in India and Burmah."
United Service Institute, Whitehall-yard, 3 p.m. Captain Walter H. James, "Magazine and Repeating Arms."
Royal Institution, Albemarle-street, W., 8 p.m. Captain W. de W. Abney, "Sunlight Colours."
Quekett Microscopical Club, University College, W.C., 8 p.m. Annual Meeting.
Clinical, 53, Berners-street, W., 8½ p.m.
Browning, University College, W.C., 8 p.m. Mrs. Glazebrook on "*A Death in the Desert.*"

Friday, Feb. 26...Metropolitan Association for Befriending Young Servants (At the House of the Society of Arts), 2½ p.m.
Physical, Science Schools, South Kensington, S.W., 3 p.m. Mr. James Swinburne, "Note on Prof. Carey Foster's Method of Measuring the Mutual Induction of Two Coils."
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Sound"

Journal of the Society of Arts.

No. 1,788. Vol. XXXV.

FRIDAY, FEBRUARY 25, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list of subscriptions promised by members of the Society of Arts to the funds for the Imperial Institute since the list published in the last number of the *Journal*:—

	£	s.	d.
Sir Augustus J. Adderley, K.C.M.G. ..	25	0	0
J. P. Benskin	10	0	0
Mark Henry Blanchard	10	0	0
Alfred W. Brind, M.Inst.C.E.	1	1	0
Wilberforce Bryant	52	10	0
Frederick Chamberlin	1	1	0
Somers Clarke	5	0	0
Henry Creed	1	1	0
Sir Robert Dalzell, K.C.I.E., C.S.I., LL.D.	25	0	0
Charles E. De Rance, F.G.S., F.R.G.S., A.I.C.E.	5	0	0
Lieutenant Charles E. Gladstone, R.N.	1	0	0
Edward W. Hammand	2	2	0
Robert Hughes	5	0	0
Robert Hesketh Jones, J.P.	5	5	0
Robert H. Julian	0	10	6
C. de Kierzskowski-Stewart	5	5	0
Alfred E. Lean	0	10	6
A. R. Macdonald	2	2	0
George B. C. Leverson	10	10	0
W. G. Pedder, C.S.I.	5	5	0
John Procter	21	0	0
Alexander Rogers	1	1	0
Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., M.P.	1	0	0
Ebenezer Viney	5	0	0
Amounts previously acknowledged	1,620	5	0
Total	£1,821	9	0

CANTOR LECTURES.

Mr. W. Y. Dent, F.C.S., F.I.C., delivered the second lecture of his course on "Building Materials," on Monday evening, 21st inst., in which, after describing the various limestones used as building stone, and the methods of testing the quality of stone and preserving stone, he gave a particular account of artificial stone, terra-cotta, and firebricks.

The lectures will be printed in the *Journal* during the summer recess.

In consequence of ill-health, Dr. Fredk. H. Bowman will be unable to deliver his course of Cantor Lectures on "The Structure of Textile Fibres," announced for April 25 and four following Mondays. Mr. J. M. Thomson, Sec.C.S., will therefore deliver the concluding course, which will be on "The Chemical Changes of Putrefaction and Antisepsis," and will be given on Mondays, May 2nd, 9th, 16th, and 23rd.

MOTORS FOR ELECTRIC LIGHTING.

The latest dates for receiving entries for this competition is Monday next, 28th February.

The conditions of the competition and forms of entry can be obtained on application to the Secretary. The conditions were printed in full in the number of the *Journal* for January 28th.

Proceedings of the Society.

SECTION OF APPLIED ART.

Tuesday, February 22nd, 1887; Edward J. Poynter, R.A., in the chair.

The paper read was—

WROUGHT IRON.

By J. Starkie Gardner.

The subject of "wrought iron" presents so many aspects, that it is not easy to settle how best to treat it within the time at our disposal. I presume that I have been invited here as an employer of blacksmiths, to give you the results of my experience in that capacity; but I do not think that an evening would be so profit-

ably spent in merely describing the practice of smithing, in the absence of forges to illustrate the process, as in a more comprehensive view of the whole subject.

I may assume that the majority present do not require to be told anything about either the sources or the production of iron, but for the benefit of the rest, I would crave a few moments' patience whilst I endeavour to put them in possession of just sufficient information to enable everyone, whether well informed at the outset or the reverse, to leave off with a clear conception of the subject.

There are some reasons for inferring that iron, as met with in the principal ores known to us, is no longer in the normal state, and that man, in rendering it molten, is at infinite pains to restore the metal to a purity which it only lost in entering into the composition of that merely superficial crust of the earth in which we find it. Nearly pure native iron has been brought up in the basalts and gabbros of those deeply-seated bygone eruptions, which for magnitude, contrasted with those actually witnessed by man, were as the gash of a razor to the prick of a pin. Masses of native iron up to 50,000 lbs. weight were found on the beach of Disko Island by Baron Nordenskiöld, which were unquestionably derived from the adjacent basalt; whilst the samples from other bodies in space, which frequently reach us in the form of meteorites, though composed wholly of terrestrial elements, sufficiently prove that the abundant iron in them has not undergone those changes which the presence of oxygen, carbon, &c., in the crust of our earth have brought about. The known density of the earth, the composition of the sun, the magnetite and Titanic iron of our lavas, go far to indicate the possibility of the existence of masses of perhaps native iron at some depth towards the interior of the earth, and the erupted lavas may even, by a flight of the imagination, be likened to the slags from smelting furnaces. This fanciful resemblance is indeed heightened by the occasional reproduction in the latter of quartz, compact silica, garnets, augite, and other natural products familiarly met with in the former.

For the present, however, our supplies are mainly derived indirectly from the wearing away of erupted rocks, and the redeposition of their material, after being subjected to various kinds of sorting processes, as sedimentary rock. We can choose for our manufacture iron in combination with oxygen, such as hæmatites, limonites, bog-ores, &c.; or with carbon, such as clay-ironstone or spathic ore. The choice is great, for all the resources of nature's laboratory, heat, pressure, solution, precipitation, have been at work for countless ages, resulting in endless combinations with the varied elements with which the iron has been brought in contact, so that the existing varieties of oxides, carbonates, phosphates, and sulphides, are innumerable. We use them indifferently, whether derived from Palæozoic rocks formed myriads of ages ago, or lake-ores formed within the lives of living people, and they are so abundant that, unlike coal, there is no fear that the supply will ever come to an end.

These impure ores are brought back to a relatively pure state by the process of smelting in brick furnaces supplied with fuel and continuous blasts of heated air. The ore is generally calcined, and the furnaces are fed with it and coal, in the proportion of about three parts of fuel to one of ore, and with a certain proportion of limestone as a purifier or flux, for the removal of the earthy matter of the ore. The metal, being the heaviest, drains to the bottom when fused, and is run off into moulds, when it becomes pig-iron, and is ready for use in foundries; but it has taken up too much carbon from the fuel to be available at once for the manufacture of wrought iron, and must, therefore, be subjected to various further purifying processes. Until coal came into general use, these further processes were not separated from the smelting, and malleable iron was produced direct from the ore with charcoal fuel by continuous working, and to some extent by the further subsequent manipulation of the smith.

The operation must at first have been of the simplest kind, the apparatus employed having probably resembled some of the primitive furnaces described by Dr. Percy as still in use in India, which consist simply of a closed hearth of carefully dried clay, and bellows.* Dr Percy believes, however, that as early as

* The simplest described furnace is of clay, carefully dried by fire, and is two to four feet high, with two holes for the earthen pipes or tuyers which convey the blast, and a hole on the opposite side for the removal of cinder. It is filled with charcoal and lighted, and as this becomes consumed and sinks, the ore is supplied until the full charge is reached. The bellows are worked the whole time, and at the end of four to six hours a small mass of malleable iron is removed, and if sufficiently hot, at once hammered into a bloom. There is no division of labour, and the smelters are itinerant, going from village to village, and setting up their furnace wherever a demand for iron exists, and a supply of iron and charcoal can be obtained. (Percy's "Metallurgy—Iron and Steel," 1864, p. 257.)

the time of the Roman occupation of Britain the ore was reduced in somewhat larger furnaces, and by a process which he distinguishes as the Catalan.* The iron was not actually rendered molten, but was separated out and made to coalesce into a solid lump whilst in a pasty condition, and was taken out sufficiently free from carbon to be at once malleable. It was then placed under a tilt hammer weighing from 1,200 lbs. to 1,500 lbs., worked by a rough cog-wheel, and driven by water-power. Prof. Roberts-Austen informs me that the use of such hammers was very common in Surrey and Sussex, and that the name "hammer-pond" still denotes, in many places, the artificial pond which supplied the water-power. It was beaten into bars on a slightly tapering anvil about 27 in. long and 10 in. wide, and was in all probability worked into sizes roughly to suit the smith's requirements. The data, unfortunately, for tracing the actual steps in the history of the production of iron in the Middle Ages do not exist, or are unknown to me; but the change in the style of smith's work in the 15th century, when high railings with ponderous angle-bars came into vogue, no doubt resulted from, or necessitated, a change in the manufacture of the raw material. The occurrence of a cast-iron tombstone in Burwash Church, Sussex, believed to date from the 14th century, clearly shows indeed that some more advanced form of furnace must have been in use at that time. Blast furnaces originated, according to Dr. Percy (*loc. cit.*, p. 571), in the district of Siegen, Prussia, in the beginning of the 15th century; but the Stückofen, which he describes as a Catalan forge extended upwards into a shaft (p. 319), must have been of earlier date, and was capable of producing both cast and malleable iron. Another ancient form, intermediate between the Catalan and the blast furnace, is the Swedish "Osmund" furnace, used in 1864, and perhaps even now, which produced either a lump of malleable iron, or fluid cast-iron, by varying the proportion of fuel to ore in the charge. It seems probable that by the time of Elizabeth the high blast furnace had generally superseded those in which malleable iron was directly produced, for cast cannon, fire backs, andirons, &c., in general use. In 1676, we read that the pig-iron was taken from the blast furnace to the open hearth charcoal finery, softened, and worked into a lump. "This they take out, and giving it a few strokes with their sledges, they carry it to a great weighty hammer, raised likewise by the motion of a water-wheel, where applying it dexterously to the blows, they presently beat it out into a thick short square. This they put into the finery again, and heating it red hot, they work it out under the same hammer, till it comes into the shape of a bar in the middle with two square knobs at the ends. Last of all, they give it other heatings in the chafery, and more workings under the hammer, till they have brought their iron into bars of several shapes and sizes, in which fashion they expose them to sale." *

It is scarcely probable that these fineries turned out more than from two to four tons of metal per week, and the production of iron in England was not estimated at more than 17,000 tons per annum, until the discovery that it could be smelted with coal, instead of charcoal, gave the industry an enormous impetus. Though the first patent for this is dated 1611, none seems to have been actually used till Dudley succeeded in working the invention profitably in 1620.† The merit of completely solving the problem belongs, however, to Mr. Darby, who introduced its use in the Coalbrookdale Ironworks in 1720.

Pig-iron, as produced in the blast furnace, contains a per-centage of carbon that renders it unworkable, and has to be removed by the action of oxygen at a high temperature. Before the discovery of puddling, the pig was

* Dr. Percy says:—"The metal was obtained by a method no doubt closely resembling, if not identical with the Catalan process" (*loc. cit.*, p. 876). Neglecting all details of construction, for which the original work, (p. 278) must be consulted, this furnace may be described as a rectangular cavity or hearth, of various dimensions, within a building. Three sides were formed mainly of iron and clay, and the fourth of stones luted with clay, while the bottom consisted of a flat or slightly hollowed refractory stone, such as granite. On one side the tuyer passes through a small arched opening about eighteen or nineteen inches from the bottom. There was no chimney, but a hole was left in the roof. A Catalan forge employed ten men in France. The ore is first crushed under a hammer and sifted. The furnace is heated with charcoal, which is packed almost as high as the bottom of the tuyer, when alternate layers of ore siftings and charcoal are piled up so as to form a ridge, one slope of which is covered with moistened charcoal breeze, beaten well down with a spade. The blast is turned on, and the level kept up by additions of ore and charcoal. At the end of about six hours the iron has coalesced into a solid lump at the bottom, which is lifted over the edge of the furnace by levers, and is ready for hammering.

* "An Account of the Ironworks in the Forest of Dean," by Henry Poole, Esq. "Philosophical Transactions," vol. xi. p. 391, 1676.

† "An Account of the Ironworks in the Forest of Dean," by Henry Poole, contained in the "Philosophical Transactions" for 1676, seems to contradict this. As quoted by Percy, *loc. cit.*, pp. 590 and 886, it states that though charcoal was used in the blast furnaces, sea-coal was the fuel used in the open hearth or finery, and in the chafery or reheating forge. Swedish and other charcoal iron is still made in direct contact with charcoal fuel.

worked into malleable iron in a charcoal finery in contact with the fuel and under a blast of air. It was not perfectly remelted, but fused into one or two lumps, and hammered under a heavy forge hammer, and then drawn out into bars under the lighter and more quickly moving tilt hammer. Reheating was accomplished in a sort of blacksmiths' forge, and mineral fuel was not used because the sulphide contained in it injured the iron.*

Puddling was patented by Cort in 1784, and consists in heating the iron on the bed of a reverberating furnace, in which it does not come into direct contact with the fuel, and stirring it until it is decarburised, partly by the action of the oxygen of the air, and partly by that of the cinder added during the process. The iron leaves the puddling furnace as a spongy mass, consisting of particles of malleable iron, feebly cohering, and infiltrated throughout with liquid cinder. By hammering, these particles are welded into a solid rectangular slab, and the cinder, more or less, completely squeezed out. This process is called shingling, and was formerly the only one used for producing bar iron (Percy, *loc. cit.*, p. 693). Lever or tilt and helve hammers were always used, the latter weighing as much as ten tons, until the introduction of the stamp hammer, with vertical action, and particularly of the Nasmyth hammer in 1842. During the present century, squeezing has been partially substituted for shingling, and the iron is pressed under rolls into flat bars 14 ft. to 18 ft. long, and $\frac{3}{4}$ in. thick, by 3 in. to 5 in. wide. The iron is now ready for the final process which is to convert it into merchantable iron. The puddled bars are cut by shears into short pieces, varying in length according to requirements, which are piled in packets, raised to a welding heat in a special furnace, and then rolled into bars, or sometimes hammered before rolling (Percy, *loc. cit.*, p. 712). Sheet iron may require heating and rolling as many as six times before the finished plate is produced, and there are special slitting mills for slitting bar iron into nail-rods, &c.

These sheets and bars are stocked by the merchants supplying the blacksmith, who requires, perhaps, so insignificant a quantity of each kind that his orders would be ignored at the mills, where they roll in bulk. It is computed that there are a thousand different sections of wrought iron in the market for smithing, and it would be useless for the blacksmith to attempt to hold any great stock, as he cannot tell till the commission is received what size he will need. The choice is increased by the number of different qualities purchasable at different prices, such as Welsh, South Staffordshire, Swedish, Russian, or the high-priced Lowmoor iron of South Yorkshire, made with extreme care, and excellent for decorative use.

Such are the conditions of the industry at the present day; but before entering into the more important subject—the manipulation of the iron by the smith—we must glance for a few moments at its history.

The inquiry into the beginning of the use of iron is a purely academical one. Iron rusts rapidly, and the delicate gold or bronze enrichment of a sword or cap are exhumed in perfect preservation, whilst the blade or helm is only traceable in a trail of rust. The use of iron dates back to prehistoric periods, and the seeming preference shown by Celts and other nations for bronze weapons may have been less due to ignorance regarding the production of iron, than to want of knowledge as to the art of tempering it. Dr. Percy thinks, from the ease with which it can be reduced from the ore, that the use of iron must have preceded that of bronze, which is an alloy of at least two metals requiring a higher degree of skill to produce. Dr. John Evans, on the other hand, is, I believe, of opinion that copper and tin, whose native ores are far purer and more metallic looking than the almost earthy ores of iron, would have been first to attract attention. However this may be, the virgin iron of meteoric origin must have been highly prized indeed, and these unearthly visitors, with their mysterious origin, must have been as welcome to the savage as nuggets of virgin gold dropped from the skies would be to civilised man. It was given as prizes by the Greeks, and their word Σίδηρος, iron, seems to imply the knowledge that it had fallen from the skies, and to be genetically connected with the Latin *Sidus*, a star. Its value has not lessened, for the man of science weighs it grain by grain, and pays its weight in gold.* A whole volume

* A bar of Swedish iron 12 feet long and weighing 60 lbs is heated six or eight times whilst being drawn out under the tilt hammers moved by water-power. This refining process with charcoal alone required 20 to 30 cubic feet of fuel to produce 100 lbs. of iron.

* *Meteorites.*—See "An Introduction to the Study of Meteorites," printed by order of the Trustees of the British Museum, 1886, price 2d. This work contains the best information on the subject, in a most concise and unpretending form. From it we learn that the siderites contain 80 to 95 per cent. of iron, and 6 to 10 per cent. of nickel. The large quantity of nickel gives the metal a silvery look, and preserves

has been written on the early history of iron, bringing it only down to the time of the Romans ("La Ferronnerie," vol. 1; F. Liger, Paris, 1873). The history of its early production is, however, very obscure, and so far as England is concerned, we can only say that there are strong grounds for inferring that the ancient Britons mnufactured it on a small scale, and that under the Romans its use was greatly extended. Traces of their forges abound in the Weald of Kent and Sussex, and the Forest of Dean; but slags are also picked up in counties where there is not the remotest tradition of iron having ever been manufactured.* The further development of its history will be dealt with presently.

The subject, "wrought iron," would comprise, if followed out in detail, a description of the industries of the cutlers, ironmongers, armourers, farriers, fletchers and spurriers, as well as the blacksmiths, so that the workers in iron were a formidable body in mediæval times, and formed several powerful guilds with exceptional privileges. The blacksmiths of London in 1376 were second to none, and sent the fullest number (six representatives) to the Municipal Common Council. Their art can alone be briefly traced to-night, and even then our limits exclude any reference to it as practised in Germany, Italy, and Spain, and the East, though these countries excelled our own in the Middle Ages. We must further omit all reference to locks, keys, handles, and other small work, and to the arts of inlaying, damascening, &c., which, exquisite though they be, were produced rather by jewellers' methods than those of the brawny smith.

It is perfectly obvious, from what has been said previously, that the smith of to-day has a much easier task than his predecessors of the Middle Ages. It appears impossible to trace the exact forms of the bars which found their way to market from the Forest of Dean, or the Weald of Sussex, say in the days of Elizabeth; but considering that the bars had to be beaten out, as we have seen on an anvil under the relatively primitive tilt-hammer, it is improbable that any great variety of section was produced, or that the angles of the bars were mathematically true. The "bars" were in fact probably analogous to the "puddle bars" of to-day, that is, very elongated ingots ready to be fashioned into finished bars, but not themselves available to be cut up and used without labour, like the bars from the rolling mills at the present day. The fact alone that the smith had to beat out most of the sections himself in the Middle Ages has caused a most pronounced difference between mediæval and 19th century smiths' work, and must ever be kept in mind in contrasting together the work of such widely different ages. Few of us probably sympathise with those who affect to prefer, as a matter of taste, the ugliest old production to the most beautiful modern one, but it is perfectly true of old ironwork that it possesses interest and attractions which few examples of modern work can possibly equal. If you enter a cathedral where some happily surviving antiquity has been made the theme for reproduction in modern times, such as the grill work in Canterbury, Winchester, or Chichester cathedrals, you immediately become conscious, without being an antiquary or specialist, and without being able at first perhaps to define precisely why, which is the old and which the new. The explanation is simply that the olden time smith cut a piece from his shingled bar, which he judged by the eye would beat out into a rod of a given length, and curl up into a scroll of the desired form. More or less sufficed for him, and by his method of work, he produced an irregularity and play in even the most monotonous design which is artistically charming to us, but which was perhaps even a source of chagrin to himself. The modern smith, on the other hand, when he receives a commission, buys the required number of rods, cuts them up into pieces of exactly the same length, makes a standard pattern, and if there is much repetition, a tool to gauge the scrolls and insure their uniformity. If there is any irregularity it is considered bad smithing, and if under the conditions it is the result of mere carelessness,

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it to a large extent from rust. This class of meteorite is rarer than the stony varieties called aerolites, and but few (only eight) have been actually seen to fall.

Value of Meteorites.—Mr. Bryce-Wright, the well-known mineralogist, informs me that the prices of meteorites range from £3 or £4 per lb. weight, to as much as £12 per ounce—such as the Wold Cottage meteorite of Yorkshire. Some of the Russian meteorites are worth £5 to £6 the ounce, and the prices generally have been trebled within the last few years. As much as £1 for a few grains of the rarer meteorites has been paid to Professor Charles Upham Shepard, of Amherst College, U.S. Bryce-Wright, *in lit.*, January 26, 1887.

Meteoric Dust.—In addition to our almost illimitable terrestrial stores, we are receiving continuous though minute supplementary supplies from space, in the form of meteoric dust, which, though impalpable to us here, can be collected on the snows of Greenland and the higher ranges of mountains, and enters perceptibly into the composition of the sediments of the greatest depths of the ocean.

* Mr. Whitaker, of the Geological Survey, has frequently picked up iron slags in Norfolk and other counties that are not known to have produced iron.

the result may be inartistic. The aversion to straight bars seen in the oldest examples was also probably due to the fact that perhaps the most difficult task that could be set a primitive smith was to handle a long heavy bar and to beat it out perfectly true with mathematically exact and sharp angles. Another reason for the generally artistic superiority of the old work, may have been that it was only entrusted to those who had a special aptitude, and if such a workman was not forthcoming, the work was either not executed, or was made in the simplest form; whilst if he were forthcoming, the details at least of the design were left to his own fancy, and were, therefore well within his own powers. In other words, it was the existence of the skilled smith that created the demand, rather than the demand that created the smith, and it seems a reasonable inference that none such had to beg for work in the Middle Ages. When a grill was wanted for Westminster Abbey, it was not the local man who had the commission, but a smith from Leighton, or a smith from Lewes, was fetched and maintained until the task was completed. Finally, it is only reasonable to suppose that the smiths of those days were not fettered by estimate or bound by time, and that the art work was produced for art's sake, by a genuine artist, whose brains were not picked, as in these competitive days, by a crowd of imitators who copy every original design that is accessible, until the originator is weary of his happiest ideas before he has been able to derive any adequate benefit from them.

Those who have stood by the forge, and watched the sparks fly as the skilful smith deftly beats, and twists, and combines his iron, would think it the easiest of all crafts. But who, standing by the side of the musician as he draws his bow across the chords of his violin, would realise the patient study and dexterity required before he is able to make it respond at will? As no practice or teaching can make a musician unless he have an ear for music, so can no one really excel in the manipulation of iron unless he possess special aptitude. His tools are as primitive as those of the sculptor, and with hammer and anvil, forge and bellows, a bench, a vice, and a few chisels, he has to produce out of the stubborn iron, effects that may rival the work of the loom in delicacy, or form the massive entrance gates to a palace or a park. It is so simple a business, that the total cost of setting up a forge, exclusive of rent, need not exceed £20.

When rolled or beaten, iron acquires a fibrous texture which it does not possess when first cast into ingots, and which contributes towards its acknowledged superiority over cast iron, where the latter is not used in considerable bulk. Another quality possessed by this fibrous iron is malleability, which enables a bar to be flattened out or rolled up into any desired form, and yet another, ductility, which enables a thick bar to be drawn out into an attenuated wire. Finally, fibrous iron possesses the valuable property called welding, or, in other words, of uniting under pressure at a heat far below its melting point. All these properties combine to make it possible to produce effects with iron, which it is almost impossible to produce in other metals, and without which, the fine art of smithing would never have come into existence. The separate pieces, as they leave the forge, may also either be fixed together by straps of hot iron tied round them, or by bolts and rivets, or by brass or silver solder.

The first thing the modern smith requires is a design, and very often a working drawing showing the exact sizes of iron to be used, and the method of fixing them together. Some day, perhaps, our training schools may turn out a class of artisans such as exists in France and Italy, capable of designing as well as accomplishing the manual labour. One cannot but believe, so practical are the old designs, but that in most cases they were created by the smith who executed the work, after merely a consultation with the architect. The few smiths who can do this now work at a disadvantage, as, unless the artist who makes their working drawings has a thoroughly practical knowledge of the craft, he will introduce needless difficulties and intricacies which render the work unnecessarily expensive.

It would be wearisome to describe in detail all the smiths' cunning. I propose instead to treat some of the leading classes of mediæval ironwork as they appeared chronologically, and to give you a general idea as to how they were fashioned as we go on. It will be recollected that our examples are drawn from England only, with this exception, that mediæval ironwork being none too plentiful, the English examples have been supplemented by others from Western France, which was politically and artistically connected so closely with us down the 16th century, that our arts and architecture were practically one.

The earliest works in iron either existing or known in this country are the hinges to doors,

but that iron was put to multifarious uses is sufficiently apparent. The eminent antiquary, Dr. Parker, is indeed of opinion that metal-work led the way in art, and was far in advance of the contemporary mason's work. He has kindly pointed out to me that in the Cædmon MS. of the date 1006 to 1012, the capitals and mouldings of the columns are represented by the illuminator as of metal work of most exquisite character, and that the type pattern is that of the rich 13th century foliage, showing that, during the intervening centuries, this mode of ornamentation was kept in view. From these and other considerations, he infers that the art of metal-working was not only in a very relatively advanced state during our Saxon period, but retained much of the same character in the next succeeding centuries.

We are, indeed, entirely baffled when we attempt to trace the origin of the different types of hinges that prevailed in the 12th and 13th centuries. Go back as we may, it seems impossible to predicate that any one form is earlier than another. The Cotton and Cædmon manuscripts, which belong to the 10th, 11th, and 12th centuries, alone exhibit so many distinct types that it is perfectly obvious that the art of making highly decorative hinges was very far indeed from being in its infancy. They also clearly prove, as pointed out by Dr. Parker, that the Norman types of hinge are derived and imitated from the Saxon, and consequently also that the ruder types, such as that at Sempringham, instead of being the most ancient, are simply the coarser productions of less skilled smiths. In like manner, we find in remote places that styles and methods survive long after they have been abandoned in the busier centres; thus in quaint Dartmouth there are some very mediæval looking hinges on a church door which bears the date, 1631, in iron of exactly the same style as the hinge.

The hinges are thus of extreme interest as the best existing representatives of early smithing left to us, and so many examples have escaped, probably because they were closely affixed to doors, were thoroughly protected by paint, and being useful objects as well as ornamental, were rescued and applied to new doors when the old woodwork decayed. Their removal was, moreover, a tough job, which presented no temptations to the iconoclast. The hinges to cope closets, presses, &c., were no less beautiful and of the same types. In addition to the hinges, the doors were decorated with strengthening bars, handles, escutcheons, bolts, lock-plates, nails, &c., all of similar character and beauty. We must be content with a very few examples which, for reasons explained, need not be selected with any regard to date.

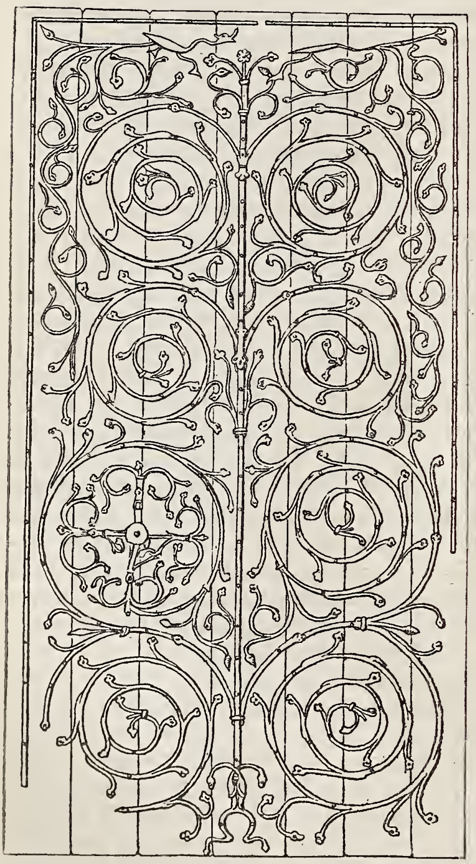
The finest examples in the world probably, and certainly within the geographical limits laid down, are those of Notre Dame of Paris. The stubborn iron seems to have been as pliable under the smith's hands as silken thread. The massive doors are almost entirely concealed, and no two pieces of ornament are similar, indeed, the dissimilarity is almost too apparent, and somewhat mars the symmetry of the design. The *motif* is supposed to be the terrestrial Paradise with its foliage sheltering innumerable birds, dragons, and other fantastic beings. There are no similar decorative hinges to the centre door, though this has been lately furnished with clever reproductions, and if any were originally executed for it, they would have been, if possible, even more elaborate. It is unfortunate that nothing is actually known about them, but they are pronounced by all competent judges to be 12th or early 13th century work, and it is quite obvious that their attribution to Biscornet, a 16th century smith, is a mere fable. This had taken such a hold, however, that Mathurin Jousse de la Flèche (La Fidèle ouverture de l'art du serrurier, 1627), regrets that Biscornet had not divulged the secret of running iron as other fusible metals. No higher tribute could be paid than this confession by the most noted smith of his day, that he was unable to conceive that anything so rich could possibly have been forged, and that he was driven to suppose they had been cast by some utterly lost process.

We have no work in England of the same kind that can possibly be held to rival them, but the famous door in St. George's Chapel, Windsor, is of about the same date, and has been placed second to them by some. The two leaves of the doors are in this case completely covered on the inside with a flowing design, which might be Italian, so free is it from conventional stiffness, and they are certainly as fine as any specimens in this country, if not finer. The illustration of these could not be finished in time to throw on the screen, but a partly finished drawing is exhibited.

Another good example, of a not uncommon type, is that on the inside of a door in York Cathedral, leading to the chapter house. Like that at Windsor, the work has no connection whatever with the hinges, and seems merely

designed to tie the wooden planks together, and to give the whole extra strength. The design is a central stem, giving off four large scrolls on each side, from which little leaves branch copiously in all directions, though always springing from the outer curve. The pretty feature is the way the whole of the inner volutes of one scroll are removed to make room for an open basket-like handle, reminding one of the basket hilts of a Ferrara or Toledo apier. True hinges of precisely similar kind of work exist at Eaton Bray and St. Mary's, Norwich.

FIG. 1.



IRONWORK TO DOOR OF CHAPTERHOUSE, YORK CATHEDRAL; 13TH CENTURY.

A still more elegant design, however, is that of which there are casts in the Tufnell-street Museum, and an illustration in Raymond Bordeaux's work on hinges. These are the hinges at Worksop Priory, Notts, and their charm lies in the fact that every scroll terminates in various beautiful representations of the iris flower. They are fixed to a cedar-wood door, and considered to be of the 12th century. The form of the iris is evidently taken directly from nature, for the pistils and stamens are faithfully represented, and the design is doubtless older than the conventional fleur-de-lis.

I have also selected the Durham cathedral hinges as a good typical example of Norman work, and because in my hasty studies I have not as yet come across any published illustration of them. They are simple yet beautiful in themselves, but the door is more remarkable for the sumptuous character of the ironwork between the hinges, the leading lines of which are unusual. Canon Greenwell informs me that the stonework dates from 1135, but that he would place the date of the ironwork towards the end of the 12th century. The pattern of the ironwork on the corresponding north door can be made out in a good light, though the iron has long since vanished. The celebrated sanctuary knocker is on a different door, and of bronze.

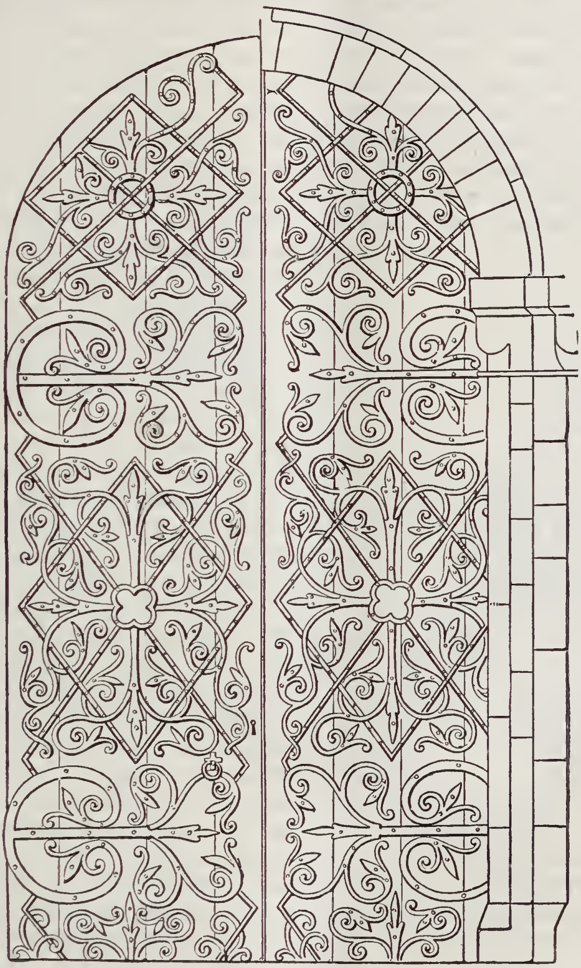
Other exquisite examples on the cope-chests in York Cathedral have only recently been illustrated. There are two chests side by side, one covered with rich and bold masculine scroll work, and the other with a delicate feminine flowery pattern. The contrast could not have been accidental, and besides serving to distinguish the chests, is of the kind which prompts one sheriff of London to select a massy green and gold livery for his state coach, and the other a more delicate foil in blue and silver. Almost the same two designs occur, though not quite in juxtaposition, in Sens Cathedral, confirming the view that the smiths were artists enough to recognise the value of complementary design. The Dean of York informs me that nothing whatever is known as to the history of these chests.

In hinges, in our country at least, strength was rarely sacrificed to ornament, while in some exposed places ornament was very properly sacrificed to strength. The fitness of the object to its pnrpose was the primary intention, and hence the forms they assume are in most cases very pleasing. There was no concealment as to the construction of the door, and every requisite detail was utilised as ornament, and, as my friend, Mr. George Birch, so eloquently put it in a lecture in this room, "the very nail-heads were things of beauty." They were seldom wrought in high relief, as in the splendid example from Hal, in Flanders,

exhibited as a cast in the South Kensington Museum; but grooving and a little incising are common features, while the modelling of the foliage, dragons' heads, &c., of such types as York and Chester, is in relatively low relief.

Now, if I were to attempt to tell you how these hinges were made, you might very properly ask me how I knew, but I can describe most minutely the manufacture of a similar hinge made the day before yesterday under my own eyes. Hinge work is, perhaps, the one branch of smithing in which the smith of to-day stands in absolutely the same position as the smith of eight centuries ago. Rolling mills have done nothing to lessen his task,

FIG. 2.

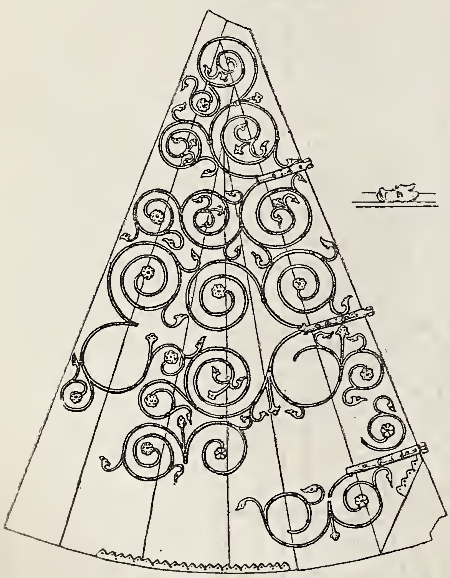


WROUGHT IRONWORK ON DOORS TO CLOISTER, DURHAM CATHEDRAL; 12TH CENTURY.

and no sections of iron can be bought ready made that are of much avail. Here is a simple hinge designed in the style of the 16th century, by Messrs. George and Peto, and made without a weld; and here a fine example of a highly decorative hinge of the 14th century character, designed by Mr. Oldrid Scott. As welding has been extensively used in its production, I had better at once describe that process. The separate parts to be welded are raised to a white heat, and become soft and pasty. When in this condition, they cannot be exposed for an instant to the atmosphere without superficial oxidation, and however quickly they may be brought to the anvil, a scale is formed. A little silver sand has, however, been sprinkled

on them in the forge, which converts the oxide into a very fusible and liquid silicate of protoxide, and when the two pieces of iron are brought together, and sharply hammered, the melted scale is extruded in showers of sparks, and the clean metallic surfaces unite. A good weld requires an expert smith, and a clumsy one will let the iron burn, when no proper weld can be accomplished. Welding is the A B C of smithing. I have marked the hinge across in red wherever it was necessary to weld it, and you will see that it has undergone the operation fully twenty times. This excessive number of welds is really easier and quicker than tapering it down from any bar that can be bought. The leaves are hammered out flat, and shaped with a chisel, and the half-round of the stems is produced by a steel punch hollowed out and hammered on to the bar while hot.

Fig. 3.



Half of a Cope Chest in York Cathedral; 13th Century Work.

The highly decorative hinges were gilt, and laid, it appears, on skins, and sometimes felt, dyed scarlet, and not directly on the wood. They fell into disuse in England during the 15th and 16th centuries, when the woodwork of doors became richly moulded and carved; but in Germany their use was continued, though thin *repoussé* work was made to supply the ornamentation at a less cost, and without welds. The German work was often tinned, and also laid on a scarlet ground.

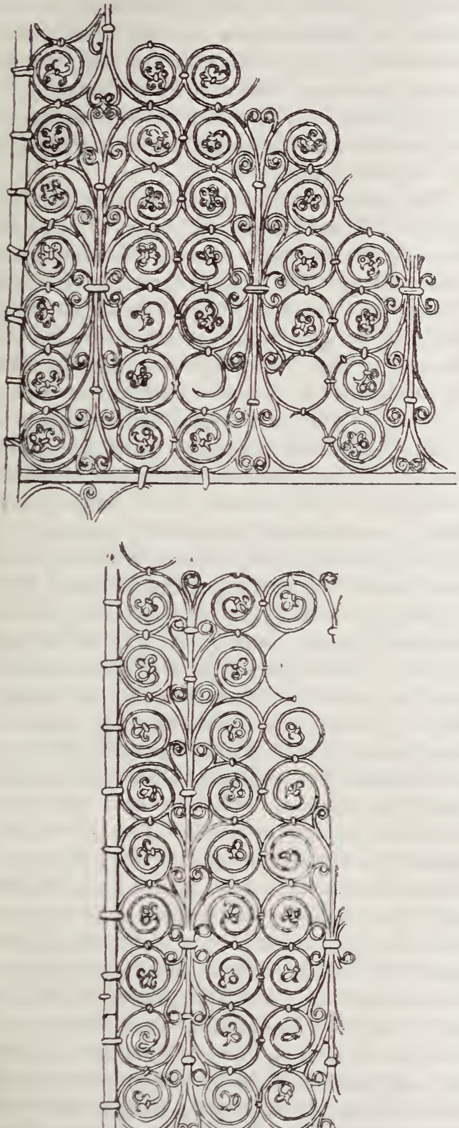
It is impossible to quit the subject of hinges without a brief reference to the mediæval safes, of which so many examples are preserved. They have been thoroughly dealt with by Mr. E. C. Robins, F.S.A. In these chests the key shot sometimes as many as twenty-four bolts, and the size of the lock was only limited by the dimensions of the lid of the chest. The ordinary type is square, with massive iron binding, and decorated with the painted armorial bearings of the owner. When we reflect that there were no insurance offices or banks, and neither cheque books nor paper money, we can readily understand that a prince or plutocrat would not be nice as to the cost of the strong box which was to contain all his worldly wealth.

The few still existing cathedral grills of the Middle Ages appeal to us as more important monuments of the smith's work than door furniture. They are more interesting and more varied, and are so few in number that I can describe them in detail.

Visitors to Winchester will have noticed, in a corner of the nave, a door patched up of four odd pieces of grill work. This, from its style, I should judge to be the oldest piece of grill work in England. The design is composed of sprays formed of two rows of scrolls welded to a central stem, like a much-curled ostrich feather, with lesser scrolls in the interstices, and the major scrolls each terminating in an open-work trefoil or quinquefoil. The large scrolls are $5\frac{1}{2}$ in. in diameter, and rather stout, the grill possessing great resisting power, though it would not be hard to climb. The Dean has kindly informed me that, before the destruction of St. Swithin's shrine, it was placed at the head of the stone steps which lead up from the south transept to the ambulatory, and here the places where it was fastened into the piers at either side are still quite easily to be traced. The Dean hopes some day to replace them there. "Their use was a characteristic one. There came crowds of pilgrims to worship at St. Swithin's shrine; and here, as elsewhere, the monks knew quite well that these devout people carried all kinds of dirt and infection about with them; consequently they rigidly excluded them from the choir, south transept, and nave, and made them enter and depart by the Norman doorway in the north transept. This grill blocked their way. They could get round far enough to see the splendour of the high altar, &c., and then had to return the way they came. From St. Swithin's the good

pilgrims always went on (if they went further) to St. Thomas of Canterbury; so that from this point they were true Canterbury pilgrims of the South-east-road—not, of course, along Chaucer's way." There is, unfortunately, no

Fig. 4.



The Winchester Grill; 12th Century Work.

means of fixing the date, since no other grill resembles it; but, from the position indicated in the cathedral, it may well have been made as long ago as the 11th or 12th century. Viollet le Duc figures one from the Cathedral of Puy-en-Vélay somewhat like it, which, he considers, dates from the beginning of the 12th century. In both cases many of the scrolls are welded together, and in the French example the face of the scrolls is covered with dotted ornament. Another grill of the same class is that of the Eglise de Conques, the design of which is more varied; and which possesses in addition a really formidable chevaux-de-frise of barbed spikes pointing downward, a little below the cresting, which is itself made up of alternating greater and less barbed, arrow-headed spikes. This would be as difficult to climb as anything of the sort could be. It is ascribed to the end of the 12th or beginning of the 13th century, and, like many of the later grills and most hinges of the period, has dragons' heads introduced into the design. Another grill of the same class has been figured by Didron in the "Annales Archéologiques," in which the design is still richer. This class of grills possessed great strength, and yet appeared extremely light. They do not correspond in the least in their lines to the masons' or joiners' work of their period, and the designs appear to have been arrived at independently by the simple process of scrolling up bars of iron of various lengths at both ends, and combining them into pleasing forms to fill in given spaces, and then welding and bolting them up together, and finally fixing them into frames.

Another class of grill which overlapped these in date, but was on the whole typical of a somewhat later period, was composed principally of a vast number of simple scrolls of small size, placed back to back and collared together. These were easier, and took less time to make, requiring, indeed, but little of the smith's skill. They were transparent, yet full of resisting power; they were lofty, not easy to climb, and, unless filling in an opening in masonry, always surmounted by a cresting in some form of spikes. The choir screen at Lincoln is the most perfect type of its class in existence. The date was said by the vergers of the cathedral to be 1442, owing to a reference to iron work occurring in the Chapter Acts of that date; but on Canon Venables very kindly referring to the original, he found that it was not a reference to the erection of any iron work, but to the removal of some. One almost identical is shown in an old view of Arras Cathedral, in the eighth volume of the "Annales Archéologiques," which secured the altar and reliquaries. The choir and eastern transept at

Lincoln were built by a saint who died in 1200, and some division between these must have been required from the very outset, and there is nothing in the style of the grills to prevent us assigning them to this date. Canon Venables also informs me that there are screens in the Dome of the Rock at Jerusalem closing in a circular choir, of precisely similar character to those at Lincoln, which must have been erected during the reign of the crusading sovereigns of Jerusalem, when a "regular chapter of canons was established in this mosque," then converted into a Christian church and fitted up for Catholic worship. The period when alone this was possible was between the taking of Jerusalem by the Crusaders, in 1099, and its recapture by Saladin, in 1187. The design may have originated at Jerusalem, and been brought back by the Crusaders, or it may have been suggested by something the smith or armourers had seen at home, and been adopted on account of the ease with which it could be made and its protective qualities. In either case, the date must be in the 12th or early in the 13th century. A similar, but decidedly later, grill, from Cravant, Yonne, is figured in the fourteenth volume of the "Annales Archéologiques," and ascribed to the 13th century.

The grill to St. Anselm's Chapel at Canterbury is of similar work, and exceedingly light, but differs in having the terminal volutes of the scrolls re-curved, as in a crozier. There is another fragment of a grill of the same class in St. Alban's Abbey.

There is here a trial panel for a grill destined for the choir of Truro cathedral, and designed by Mr. Pearson, R.A. The piece has been merely made to get the general effect, and has not faithfully reproduced his original, but it will do to illustrate the way in such a grill can be produced. The upright bars are shaped in a very peculiar way at the top, and are narrowed and brought from round to square out of the solid, except the very apex, which is welded on. The cornice is of charcoal-plate, and cut out with a chisel and rivetted on. The small scrolls are formed by cutting bars of the right section into lengths, care being taken that there shall be a reasonable variation, so that there may be no mathematical regularity; the two ends are beaten out thin, and the whole scrolled up without heat. If the iron were thicker, it would have to be made hot, and the heated end would be allowed to droop over the round of the anvil, and a few gentle taps of the hammer would cause it to fall of itself into a graceful shape. They are bound together by small pieces of heated metal, or collars. The small pieces tucked in between them, intended to give little groups of dark points, arranged geometrically against the light, are more difficult to make, and require several welds each, and, moreover, must be brazed or pinned through in two places, to prevent them working loose under the collars. The whole aim and object is to invest the work with the character of 13th century work, and to avoid the extreme regularity and high finish which invariably betrays the modern reproduction.

The grills next described belong to an altogether different class, and here we have an example of absolutely known date in perfect preservation. The grill to the tomb of Queen Eleanor was made by Thomas de Leghton for the sum of £12, besides 20s. extra for the carriage of the work, and his expenses and his assistants in London during the fixing, A.D. 1294. The constructive part is simply a framework of two horizontal bars, connected by others at right angles, on the face of which is rivetted scroll work of varied and exquisite design, and worked in much the same way as if it had been intended to be applied flat against wood work. It scarcely differs, indeed, from the hinge work of the same period, and is arranged in six panels, three of which are repeats. The whole is arched over forward and surmounted by a cresting of speary tridents, a favourite form, for they recur on the Chantrey screen of William of Wickham, at Winchester, &c., and as far off as the Scaliger tombs at Verona. Though low, this grill would not be easy to climb. The grill to the tomb of Henry III., made by Henry of Lewes, and paid for in 1290, has disappeared, and the only other example of the same description of work is at the sister Abbey of St. Denis, and figured by Viollet le Duc. Both these Abbeys were extraordinarily rich in grills and railings; but in the French case they were swept away in 1794, when the brasses were melted and the stone effigies of kings shattered and piled up in fragments to form a fitting base to a statue of Liberty, and in England, when, thirty years later, they were disposed of as old iron, because they impeded the view of the sculptures. In both cases a few seem to have escaped, chiefly because the intrinsic value of the old iron was small, and parts were stowed away as worthless lumber and forgotten. The grill to the tomb of Edward I., about twenty years later, as shown by Dart, is made up of little more

than a few plain bars crossing each other at right angles, but it is just possible some handsomer work may have been applied to the face of it.

Nearly the whole of the ornamental part of these grills was produced by aid of stamps, or hollowed moulds of steel, which are impressed on the iron whilst heated and soft. These dies or stamps are made very simply. A leaf or flower of the desired form is forged in relief in steel, and this is driven into a larger block of steel shaped like a punch or wedge, and heated to pasty condition, so that an intaglio is produced. Some dexterity is required in order to get sharp and clean impressions, as too sharp a blow from the hammer will squeeze the metal out if hot, and if too cool the impression will of course be blurred and weak. I had some time since to make a stair-rail, under Dr. Rowand Anderson, representing about this period of work, in which more than a mile of iron had to be decorated on both faces and scrolled up, the process requiring over 11,000 heats, exclusive of the welds.

All the grills hitherto described had one defect common. Though excellent in construction and magnificent in appearance, they were not unclimbable. That this defect was fatal, considering the enormous value of the treasures they were designed to safeguard, is apparent from the variously devised *chevaux-de-frises*, and spiky crestings, and arching forms, which were inherent features in them. Every device was exhausted in vain before the smiths' repugnance to undertake the production of plain heavy bars was finally overcome. The manufacture of long unwieldy bars on an anvil was a laborious, and squaring the angles mathematically, a difficult task, and on the whole, perhaps, thankless and monotonous; and very different from the production of the light and easily manageable scroll work they superseded. An imperative demand for strong and unclimbable grills carried all before it towards the second half of the 14th century, and the artisan of those days had need yield to it. Whether the tapering prongs of the trident cresting of the Eleanor type of grill, or the upright bars of this and of Edward I. grill, suggested the form commonly known as "railing," must, for the present, remain an open question, but there can be no doubt that it was arrived at by a natural process of evolution. Henceforward, for a long time, unless to fill in openings in masonry, protective grills were made up of vertical bars sufficiently massive to dispense with any cross-ties, except at the top, immediately under the cresting. These afforded no foot hold, and afforded so efficient a protection as to remain in use during all succeeding ages. The vertical bars were generally an inch square, and ended in spikes, with a top rail wide enough for them to pass through. The angle uprights, and sometimes the central one, were also stouter, as much as two inches square, and higher, and were usually surmounted with a crest of iron or carved wood. The horizontal bar was always more or less enriched on the face with plates of thinner metal embattled and pierced, and embossed to form a cornice, the work often being exceedingly elaborated, as if to show that the general simplicity was not the result of parsimony or incompetence. One of the earliest of these is that of the Black Prince, at Canterbury, and there were innumerable and grand examples in Westminster Abbey, many with large heraldic devices at the angles. Often to give extra strength, and perhaps a lighter appearance as well, the bars were twisted, the resistance to any strain being thus thrown from the face only into the diagonal. At times this was effected by twisting several bars together. For the same reason the bars were generally placed angleways instead of square. It would be utterly impossible now to follow all the developments of this type of grill, but what strikes us forcibly at every step is that nothing was introduced at haphazard, or without a definite aim in view. The crestings became more elaborate, especially in France, where grinning dragons' heads thrust forward, with spike-like ears, *fleur-de-lis*, and clusters of spiny leaves took the place of simple spikes. The cornices occupied more space, and were more elaborate; tracery was inserted underneath between the bars, often of pierced sheet iron; the angle bars assumed architectural forms, with mouldings and buttresses, and the caps and bases of the vertical bars were also moulded. The file and chisel displaced the hammer and anvil, and instead of possessing the entirely distinctive character which its method of production demanded, and which it had maintained for many centuries, it was forced to assume, at a vast expenditure of labour, the forms that are proper to wood and stone. It was not till the time of Henry VIII. that grills in this country began to emancipate themselves from the purely architectural treatment, and Queen Elizabeth's tomb in the Abbey is almost the first instance of the introduction of a border of exquisitely natural roses into a tomb rail of iron. Thence-

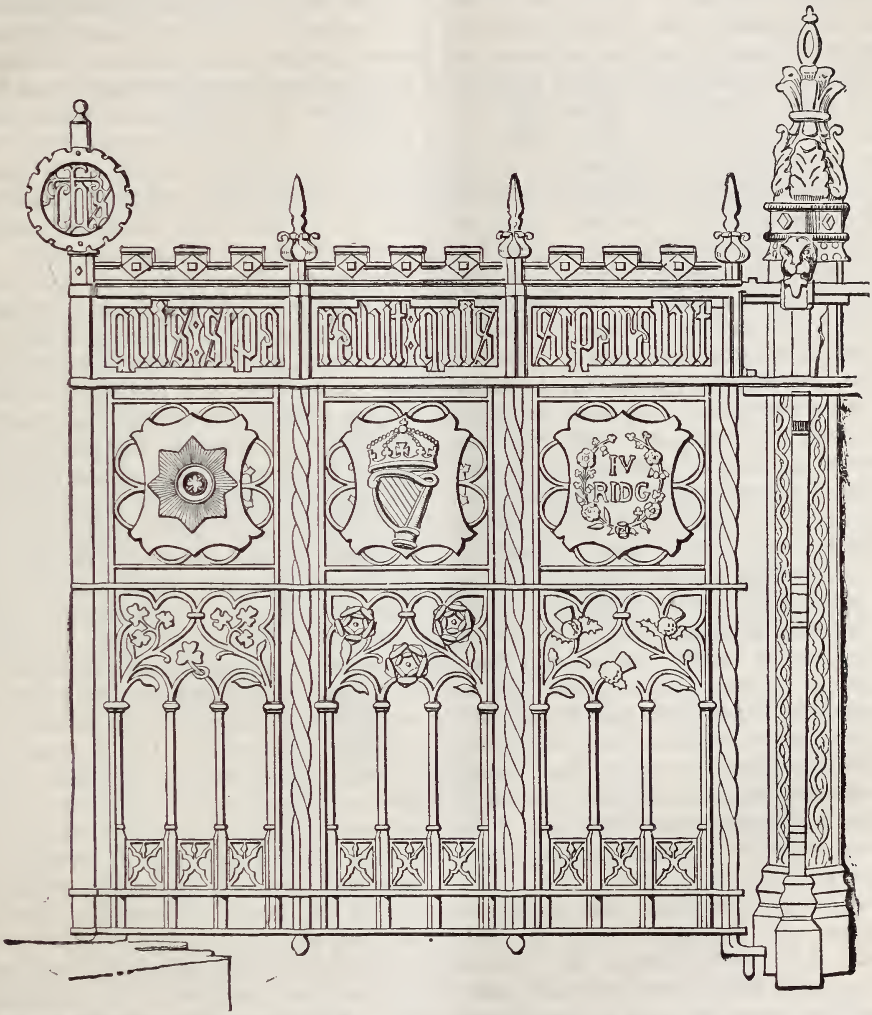
forward the railings rapidly branched out into Italian forms, and soon settled down into the groove so peculiar to England during the 17th and 18th centuries. The transitions preserved in our churches are of great interest, and also the instances where existing mediæval railings had been improved upon and modernised in the 17th century, as at York, &c.

That the vertical bar form was imposed from necessity, and not from choice, is abundantly apparent, as in cases where grills were required to entirely fill in openings in masonry—such as windows and arches—cross bars and other ornaments were introduced. The screen to the chantry of Henry V. at Westminster, and a similar grill at St. Albans, are examples where rich tracery designs could safely be substituted. The framework in these is exceedingly massive and difficult work, but a feeling of lightness is given by the introduction of much pierced sheet-iron work. We cannot delay to explain the construction, but the result imparted a strength that would almost require artillery to force. This type seems very rare. Even in the case of tomb rails there was a tendency sometimes to make them lofty, and introduce more than one cross-tie, and the bronze example round the Earl of Worcester's tomb at Windsor shows tracery between the bars carried a considerable way below the cornice; but the only example in this country, I believe, of a tomb rail in iron, in which the precaution of at least a considerable space of vertical bars was absolutely thrown to the winds, is that of the magnificent grill to Edward IV.'s tomb at Windsor. The tomb is exceedingly plain, and perhaps it was thought that there was little to protect and something to conceal; but anyhow, the utmost skill of man seems to have been lavished on the grill in front. The work consists of six bays of tracery, about 5 feet 6 inches high, and two flanking half octagonal piers, 9 feet high. The brass grill of Henry VII's tomb gives an idea of the plan, but not of the intricacy of the work. It is in the richest style of perpendicular architecture, with traceried windows, canopies, parapets, crockets, flying buttresses, pinnacles, caps, mouldings, string-courses, &c., complete. Scarcely an inch is plain, and the tracery is of all sizes, down to wire. A distinguishing feature is the magnificently worked cressets, or lanterns, surmounting the towers. The work has been attributed to Quentin Matsys, for no other reason than that it seems to have been impossible to suppose that any lesser artist could have executed it. It is not in the least in the style, however, of the well-cover at Antwerp, which seems the only work at all authentically attributed to Matsys, for the greater part of the one is as forged, whilst not a piece of the other remains in the state in which it left the anvil, It is also quite apparent that any middle-aged man undertaking its execution would have been occupied for a large part of the rest of his life in tedious mechanical work that no artist of such calibre might have cared to settle down to. It is a singular thing that there should be no record concerning its production, and we are left to guess whether it is native or Flemish. The dearth of authentic information concerning the metal work in our cathedrals, with the single and notable exception of Westminster Abbey, and of course St. Paul's, is strange and, indeed, vexatious. The grill now occupies a meaningless position beside the altar, and should, in my judgment, be replaced in front of the Royal tomb, of which it is an intrinsic and by far the finest part.

Another example of 16th century work unique in England, and also on that account attributed a German origin, is the beautifully wrought gate in Ely Cathedral. This has much more in common with the work of Quentin Matsys, the filling in of the spandrels at the top and between the uprights being vigorous and natural, and, moreover, the genuine work of the smith. The Dean informs me that tradition in fact assigns it to this master. The *repoussé* border is also delicate and good. Another exceptional grill of the 15th century is that restored in 1879 by Mr. Gordon Hills, at Chichester. The base of the grill formed what decorators call a "dado" of cross bars, with thin forged quatrefoils in the spaces; above this is a series of panels or windows, the design having been made out from fragments of the old work that had been used to patch the old gates to the Lady Chapel, and above this is a cornice and cresting. The old gates themselves are entirely made up of bars crossing each other with quatrefoils in the spaces. The value of such specimens cannot be over-estimated, as they are the fountain head which must ever inspire English 15th and 16th century reproduction. Mr. Pugin revived the taste for Mediæval metal work, but since then it has fallen into certain grooves, and repeats with monotonous regularity certain types of ornament for which there does not appear to be the least ancient authority.

It is stiff and jerky, with impossible leaves ornamented with dots and zig-zag lines, prim flowers, and twisted tube, and fretworks of stereotyped patterns. This kind of work is dying a natural death, however, and architects are more and more refusing to buy stereotyped designs, and infusing their own spirit into mediæval metal-work. I am not able at the moment to exhibit any example of 15th and 16th metal-work. I may perhaps be permitted to illustrate its manufacture by means of a cartoon of a reading-desk, recently executed from the design of Mr. Blomfield, and a memorial screen. With more notice, I

FIG. 5.



MEMORIAL SCREEN, DESIGNED BY MR. SOMERS CLARKE FOR THE 4TH DRAGOON GUARDS.

might have obtained permission from Mr. Somers Clarke, its designer, to have retarded the latter, so as to have made use of it to-night, or I might have pushed on with one of the grills for St. Bartholomew the Great, designed by Mr. Aston Webb, and have shown that in a complete form. The construction of the reading-desk is of necessity somewhat intricate, and we will pass on to the screen. The framing of this is very stout, the upright bars in all cases passing through the horizontals which bind them together. The twist is given cold, one end being firmly fixed, whilst the other is turned by sheer manual force. The spikes are hammered into form, and the buttress-pieces to the central pier are

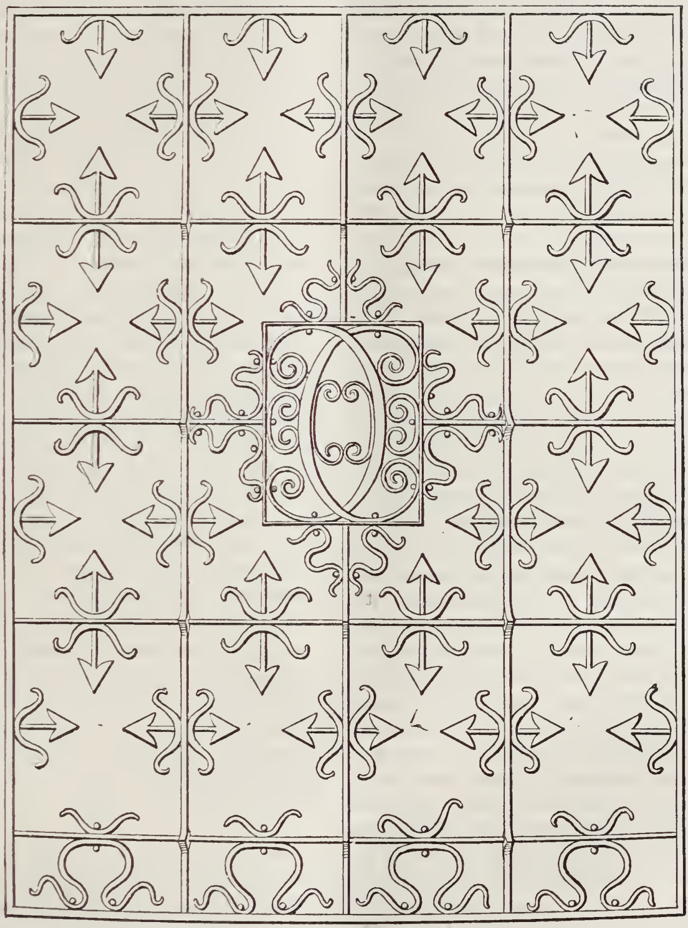
roughly hammered into shape, and finished off with chisel and file. The bars are all tenoned and rivetted together. The caps and bases of the pillars in the panels are entirely worked out by the file. The inscription is pierced with a minute bowstring keyhole saw, inserted into holes previously drilled. The buttress top is slit in the same manner, and the ends rolled down over a thin rod which is afterwards withdrawn. The leaves in the panels are hammered out of square rod, and welded on separately, and the roses are cut out of sheets of metal, and bumped up on the edge of a vice, and fixed on by brazing. The shields are embossed on a slab of pitch; the design is drawn on thin paper, and pasted on to the sheet of charcoal iron to be operated on, then pricked in in outline, the paper removed, and the relief gradually acquired by hammering with a small hammer on blunt punches of various calibre. The hammering is required on both sides, and the pitch has to be re-melted as often as the face of the iron is reversed. The dragon's head is roughly shaped when hot, a bar of iron being in the first place heated, and then jumped on the anvil and hammered up, until a sufficiently thick mass is formed at the end to allow of its production. The greater part of the production is, however, effected by actual chiselling and smoothing, as if carved from marble. The shields are fixed to the front, but the design at the back is so skilfully managed that they are not apparent, and it looks to be the real front. The design is very original, and yet so characteristic, that it might pass for old work were it not for the blazons of the Royal Irish Dragoon Guards, who erected it. But to judge of its merit it should be seen complete, with the stone and bronze work of the rest of the memorial, when the reasons for its proportions become apparent.

Comparatively little was made of iron in the Tudor and Jacobean styles of architecture. Bolts, locks, hinges, &c., are of plain character, though serviceable and quaint. The railings round the tomb of Mary Queen of Scots and Elizabeth have disappeared, but good representations show the former to have differed but little from earlier 16th century examples, and the latter have been described. The universal use of stone walls and balustrades outside, and carved oak within, reduced the smiths' art to a low ebb, and it was not till the accession of William III. that the art blazed out again in sudden splendour. The armourers with their traditions must have been available for the revived art, but wherever the workmen came from, there was no lack of skill when Tijou, a Frenchman, in 1693, published a book of designs for smiths' use, among which appeared the celebrated screens commanded a little later by the king for Hampton Court, and which were actually executed by Huntingdon Shaw. This work, and that in St. Paul's, had very much in common with the French work of the same period, but towards the beginning of the 18th century our English work diverged more and more, and assumed that peculiar mannerism which is its distinctive character, and which is called Queen Anne or Georgian. The finest examples of the earlier style are, as already mentioned, at Hampton Court and St. Paul's, and there is another fine one at 45, Lincoln's-inn-fields, admirably described by Mr. George H. Birch. The French work diverged more and more, and set a fashion in south-west Germany which perhaps culminated at Wurzburg, while an approximation to the English style prevailed in the north. The art had also survived in France whilst it was dormant here under the Stuarts, and in a fashion that has no counterpart in this country. A staircase designed by Dr. Rowand Anderson for the Central Hotel at Glasgow, has admirably caught the feeling of Henri II., and consists of pleasant alternations of light and shade, and of strength and delicacy. I am also permitted, by the kindness of Messrs. Jackson, to exhibit a panel from a very handsome stair-rail of Louis XVI. style, of polished iron, the construction of which would be of interest did time permit a detailed explanation. Of the same work is a large basket-shaped chandelier and a lantern, designed by Mr. Edis for the grand staircase of Chesterfield-house, where there is a fine original stair-rail of wrought iron, apparently French in design, if not execution, and of the time of Louis XV. The same architect designed the very quaint and exceedingly protective grill which I have photographed from the front of the Constitutional Club. There is an intensely *noli me tangere* look about it, without any loss of decorative effect, and it seems altogether so happy that, though of foreign style, I have reproduced it. The large gates, by Mr. Sydney Mitchell, like those recently executed for the South Kensington Museum by Mr. Taylor, architect to the Office of Works, are not founded upon any particular models, but seem admirably designed for the buildings that receive them; but the large gates exhibited, which were

designed for Gordon College, Aberdeen, by Mr. Marshall Mackenzie, are more distinctive of the English 18th century work, good examples of which are to be seen in every suburb of London, and scattered over the country.

Perhaps on a future occasion I may, if desired, go more deeply into the 17th and 18th century work, which deserves at least an entire evening. I cannot conclude without expressing my thanks particularly to three men from whose hints and instructions at an early period of my career I was able to gather almost all I have told you to-night. These are Mr. L. Karslake, Mr. W. Unsworth, and Mr. G. H. Birch, whose support, with that of Messrs. Ernest George and Peto, Dr. Rowand Anderson, and Mr. C. Baker King, enabled me to found a factory, and in some respects a training school, which has not, I trust, proved altogether useless, and by which I believe many engaged in the same manufacture have more or less directly profited. I do not of course allude to those old-established firms who were pioneers when smithing as a fine art did not exist, but to those who have entered the business in my own time, and who seem to think it more easy to learn from their neighbours than direct from the older examples, which are common property to all alike.

Fig. 6.



Grill in the Constitutional Club, designed by Mr. R. W. Edis, F.S.A.

[A series of drawings of English historical iron-work, by Mr. O. Allbrow, was kindly lent for exhibition by the Science and Art Department.]

DISCUSSION.

Mr. E. C. Robins, having expressed his admiration for the beautiful drawings with which the paper was illustrated, said he was not practically acquainted

with this subject, but as an architect he had had to deal with it, and as a designer should be delighted to hear practical men point out the differences of construction, so as to avoid in future the mistakes which were sometimes made from not understanding how these things were made. Mr. Gardner had treated the subject entirely from the artistic point of view, not from the constructive. Two previous papers had been read by Mr. Skidmore and Mr. Stannus, on the same subject, one from the artistic standpoint and the other from the constructive; but this one was pre-eminent for the beautiful designs which had been shown, and which were adapted in some cases for everyday use. His own experience showed him that the taste for iron work was growing, and the advantage of having such teachers as Mr. Gardner, who had evidently studied both practice and theory, could not be over-estimated. It had been said that there was nothing new in this world, and it was evident that the examples of old iron work which were still to be found in some of our cathedrals would be worthy of study in all time to come.

Mr. Townsend said he should have been glad if Mr. Gardner could have given even more specimens of the ancient iron work to be found in our cathedrals. There were some very fine examples in Worcester, especially one of a form rarely seen, namely, of round iron, the grills generally being made of flat or square section; but this round iron work was very beautiful, and he was somewhat surprised it was not more used at the present time. They must all look with admiration on the ancient work which few perhaps could reproduce in all its details, but they must not forget that the English work produced at the present day was often much superior in appearance to the old work. For instance, in old scroll work you rarely saw one scroll correspond with another; and the leaf work produced now was a great improvement on the ancient work. The screen which was to be seen at the South Kensington Museum, and was much talked about, showed leaf work of a very poor and second rate character. There were several places in London where very fine specimens of wrought iron work could be seen. With regard to the practical part of the question, he should say that the fewer the tools which were used the better the work would be. The hammer and chisel were the principal tools, if a man went the right way to work. He had been a smith for twenty years, and all his tools would not fetch more than about 14s. 6d.—simply a hammer, a sledge, a pair of tongs and a cutter, a vice, and a few files; but very little filing was required if the work were properly forged; leaf work should be done entirely by the hammer. You could not produce a leaf by machinery to look like one which grew in the fields, or on a shrub; it must be done by the hammer.

Mr. G. Aitchison, A.R.A., said he had not paid any particular attention to the question of wrought iron work, but, like all persons of his profession, he had had the opportunity of seeing a great many specimens of it in different parts of the world, and though possibly modern work was exceeded by old specimens, it must be obvious to anyone who used his eyes that the art of working in iron had made extraordinary progress in England during the last quarter of a century. It was quite a delight to him, in walking through many of the streets, to see small grills put up at shop doors, fan-lights, and things of that sort, which were most charmingly artistic. The excellence of the 13th century work was very peculiar, because it coincided with an extraordinary development of mankind generally. The later barbarians, who had overturned the greater part of the world, had been converted to a new religion; they were men of unbounded courage and tremendous energy, and they were suddenly confronted with men semi-civilised, also converted to a new religion, and in mixing with that people they passed through the great centres of the world where the arts had flourished many hundreds if not thousands of years before, through Rome, Constantinople, and the whole of Asia Minor, Syria, and Palestine. There they became acquainted with these things, and came back and tried to put into execution of what they had seen. At such stimulating times, men were excited to greater energy and vigour than usual. He regretted that Mr. Gardner had not shown some of the finer specimens of Italian and other work of the 15th century, for there they had not only all the art which had preceded them, but also the finest remains of Roman and Greek art which the world had ever seen; but the Italians, a most brilliant race, especially in the North of Italy, had added to all this something of their own, which gave a peculiar character to all the work which came from Florence and the small republics about there; and was carried throughout the world by Italian workmen and artists The celebrated cresset made for the Medici at Florence was a thing which struck the observer more than any other piece of work ever executed. He joined Mr. Robins in wishing that Mr. Gardner had given architects some hints how to avoid giving smiths unnecessary trouble.

Mr. Haite said he differed from Mr. Gardner, though with great deference, as to the derivation of some of the ornamental work he had shown; in particular one specimen which he thought had been suggested by the flower spike of a rush or grass. It seemed to him quite possible that that emanated from no natural form at all, but was simply consequent on the conditions and restrictions of material in which the artist worked. It must also be borne in mind that very much of the old ecclesiastical decoration was based upon symbolism. But if that ornament were derived from anything at all in nature, it was most probably derived from the *fleur de lis*, or iris. There was a peculiarity about that plant that when one of the flowers died off, instead of falling, it

remained curved up in a beautiful twist, and if he were using the flower for decorative purposes in iron work he should very likely use the dead flower in that way. With regard to the large door at Notre Dame, which Mr. Gardner took some exception to on account of the great variety of detail, and its not being properly balanced, it appeared to him to be very beautifully proportioned and balanced, with the exception of the centre panel ornament on the left-hand side; but in order to judge of it properly it should be seen in its natural size; it was very difficult to form a judgment otherwise, but it seemed to him that if a larger portion had been left plain, it would have struck the observer as being very empty in comparison with the ormentation of the surrounding stonework. He was, therefore, rather in sympathy with the artist, though he did not believe in over-ornamentation, and thought an artist often showed his taste as much in what he left undone as in what he he did.

Mr. HALL asked if Mr. Gardner found any difficulty in getting smiths who could carry out this artistic work. In old days no doubt they took a great deal of trouble to do their work well, but he believed they had their own time to do it in, whereas now most of the work was spoiled because it was hurried through, and could not be done in a proper manner. That was the great difficulty at the present time, there was so much competition; and as Mr. Gardner must know, an article was produced now for a third of the price, and in one-third of the time it would formerly have required. The draftsmen no doubt had an important part in the production of this artistic work, and they were provided for by art and technical schools; but, after all the work had to be done by the smith, and, therefore, he should like to know if there was any difficulty in finding capable workmen.

Mr. A. GARDINER said he had done a considerable amount of scroll work, but the great difficulty he always met with was that owners of buildings found it too expensive, and so they would not go in for ornamentation. He had men in his employ now who were as capable of doing the work as any ever had been.

Mr. AITCHISON said if they could believe the accounts which M. Viollet Le Duc gave of the work of the Middle Ages, instead of being very slow, it was done with almost incredible rapidity. It was the general belief that in the Middle Ages everyone had plenty of time at their disposal, but the fact was, that in consequence of the rapid changes and wars which were always taking place, all work was hurried, and he doubted if work could be done so quickly now as it was then.

Mr. HUNTER DONALDSON thought it would be a great help to workmen in this branch of art if what was being done in Germany and Italy at the present day were more generally known amongst them. He was a very recent business associate of Mr. Gardner, but he knew he was giving a great deal of time and attention to the production of really artistic work at a singularly low price, so low that it was brought quite within the reach of ordinary persons. There were beautiful specimens of German and Italian work, not to speak of Flemish and French available for the guidance of English workmen, and it could be done at an exceedingly low cost. There were beautiful books published in Germany on this subject, and nothing would do more to develop the taste of the English workman than to make him acquainted with what was being done by his competitors of the present day. Everyone must sympathise with Mr. Gardner in having such a vast subject and such a limited time in which to deal with it, and he hoped they might have another opportunity of hearing him further upon it, when he might deal with the iron work of France, Belgium, and Italy.

The CHAIRMAN said he presumed that international exhibitions were really the means by which the workmen of one country became acquainted with the works of others, and he did not quite see how to introduce specimens of the modern works of other countries into museums like South Kensington. He presumed Mr. Gardner's answer to the question which had been asked would be that he trained his own workmen. That would probably be the case with any director like Mr. Gardner. He had been called to account for not dealing with various points, but he thought they must be very grateful to him for what he had done in the time. Being ignorant of the subject himself, it would be presumptuous in him to offer any remarks beyond endorsing what had been already said on the general artistic interest of these beautiful designs which had been shown, and which would be really very useful both to designers and workmen, if they were studied in the spirit in which they were explained, viz., as to the method by which they were constructed, which no doubt led quite as much to the form of the design as the design led to the process of construction. If they were studied in the spirit—not that of slavish imitation—they would do a vast amount of good. He concluded by proposing a hearty vote of thanks to Mr. Gardner.

The vote of thanks having been carried unanimously,

Mr. GARDNER, in reply, said he had never before attempted either to speak or write on art, and therefore his shortcomings must be excused. He quite agreed with Mr. Aitchison that the smiths in the Middle Ages must have worked much quicker than men did now, otherwise it was inconceivable that the intricate designs used in Germany, Spain, and Portugal, for ordinary domestic houses, could have been produced at any price which would have suited the occupiers. The workmen must have got through the work with a rapidity we had not yet attempted to reach. A great many skilled men

came to him, and when they had had some little practice, a very high average indeed was reached. He thought the supply was quite equal to the demand, or, at any rate, it would be in a very short time. The question of the derivation of ornament was one that it was impossible to enter upon then, but no doubt there was a good deal to be said for and against the views he had put forward, the correctness of which, however, he was quite able to sustain.

ELEVENTH ORDINARY MEETING.

Wednesday, February 25th, 1887; WILLIAM ANDERSON, M.Inst.C.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Barriball, W. T. H., 2, Corbyn-street, Hornsey-road, N.
Evans, Robert, South-road, The Park, Nottingham.
Hewitt, James Francis, Devoke-lodge, Walton-on-Thames.
Puleston, John Henry, M.P., 7, Dean's-yard, Westminster, S.W.
Scorer, Alfred George, Abercorn-lodge, Upper Hamilton-terrace, N.W.

The following candidates were balloted for and duly elected members of the Society.

Hall, Carl, Grosvenor-house, Swansea.
Jacks, Thomas William Moseley, 72, Stafford-street, Wednesbury.
McMorran, Alexander, Galloway-house, Carlton-road, Putney, S.W.
Mockford, Henry, 13, Manson-place, Queen's-gate, S.W.
Ryland, William, Rye-lodge, Nether-edge, Sheffield.
Stocken, Alfred William, 5A, Halkin-street, Belgrave-square, S.W.

The paper read was—

RECENT ADVANCES IN SEWING MACHINERY.

By JOHN W. URQUHART.

The distinct improvements in sewing machinery, to which I would invite your attention this evening, have reference more particularly to the results of inventive effort within the past ten years. But although marked development in the machines has occurred in so short a time, it may be taken for granted that those advances are but the accumulated results of many years' prior invention and experience of stitching appliances.

The history of the sewing machine, and the decision of the great question—who invented an apparatus that would unite fabrics by stitches?—do not at present concern us. Many sources of information are open to those who would decide that extremely involved problem. But whether the production of the first device of this kind be claimed for England or for America, it is quite certain that no one man invented the perfect machine, and that those fine specimens of sewing apparatus shown here to-night embody the labours of many earnest workers, both in Europe and America.

Most of us are familiar with the arrangements of an ordinary lock-stitch machine, and an able paper by Mr. Edwin P. Alexander, embracing not only a good account of its history, but most of the elements of the earlier machines, has already (April 5th, 1863), been read before you. This, and sundry descriptions of such apparatus in the engineering papers, confine my remarks to the more recent improvements in three great classes of machines. These are, briefly, plain sewing machines; sewing machines as used in factories, where they are moved by steam power; and special sewing machines, embracing many interesting forms, only recently introduced. We have thus to consider in the first place, the general efficiency of the machine as a plain stitcher. Secondly, its adaptibility to high rates of speed, and the provision that has been made to withstand such velocities for a reasonable time. And, thirdly, the apparatus and means employed to effect the controlling of the motive power when applied to the machines.

To deal with the subject in this way must, I fear, involve a good deal of technical description; and I hope to be pardoned if in attempting to elucidate the more important devices, use must be made of words but seldom heard outside of a machinists' workshop.

It appears scarcely necessary to premise that the sewing machine of twenty years ago has almost faded away, save, perhaps, in general exterior appearance; that the bell-crank arms, the heart cams, the weaver's shuttles, the spring "take ups," rectangular needle bars, and gear wheels, have developed into very different devices for performing the various functions of those several parts.

The shuttle is perhaps the most important part of a lock-stitch machine. But what is a shuttle? So many devices for performing the functions of the early weaver's shuttle have been introduced of late, that the word shuttle,

if it be used at all, must not be accepted as meaning "to shoot." We have vibrating shuttles, which are, strictly speaking, the only surviving representatives of the weaver's shuttle in these new orders of machines; and stationary shuttles, oscillating shuttles, and revolving shuttles, besides the earlier rotating hook, in several new forms, difficult to name. But the general acceptation of the word shuttle, as indicating those devices that pass bodily through the loop of upper thread, is, I venture to think, sufficiently correct.

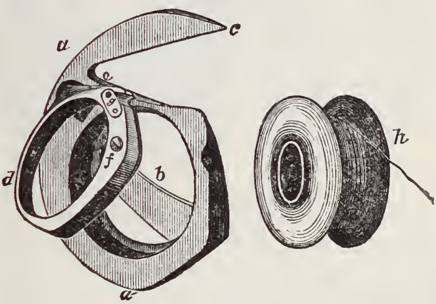
Many changes have been effected in the form, size, and movements of the shuttle, and we may profitably inquire into the causes that have induced manufacturers to abandon the earlier forms. The long, weaver's kind of shuttle, originally used by Howe and Singer, had many drawbacks. Mr. A. B. Wilson's ingenious device, the lock-stitch rotating hook, was not free from corresponding faults. The removal of these in both has led to the adoption of an entirely new class of both shuttles and revolving hooks. It is well known that the lock-stitch is formed by the crossing of two threads, one of which lies over, and the other under, the cloth to be sewn. This crossing point, to insure integrity of the stitch, must occur as nearly as possible in the middle of the thickness of the fabric. The crossing must also be effected while a certain strain, called tension, is imposed upon both threads. If the tension of one thread should outweigh that of the other, the locking point becomes displaced; if the tension be insignificant, the stitches will be loose; if the tension should vary, as in the long shuttle, there will occur faulty points in the seam.

In the earlier rotating hook the tension depended upon the friction developed between the spool and the hook. This tension, therefore, varied in proportion to the speed of the latter, and could never be constant. This was quite apart from the frictional resistance offered to the upper thread in passing over the cavity of the hook.

In the shuttle the tension was obtained by threading through holes in the shell, or beneath a tension plate, as in Howe's machine. This tension, so long as the reel ran between spring centres, was never constant. The variation was chiefly due to the angular strain set up when unwinding from the reel. This strain varied according to the point of unwinding. It was light in the middle of the reel, and heavy at either extremity. These drawbacks caused immense anxiety to the first makers of sewing machines, and numerous attempts to overcome them led to little improvement. With reference to high rates of speed, the older shuttle, requiring a long and noisy reciprocation, had its disadvantages.

The only effective remedy for these drawbacks was a radical one. It was necessary to substitute depth of reel for length. Hence, several attempts have been made to construct disc or ring shuttles. Many forms of those have been tried. They all depend upon the principle of coiling up the thread in a vertical plane, rather than in horizontal spirals. Some makers placed the disc in a horizontal plane, and caused it to revolve. Nothing could be worse, as will be seen, if we follow the course the enveloping loop must take in encircling such a shuttle. But a complete solution of the difficulty of employing a ring shuttle has been achieved in the oscillating form, invented by Mr. Phil. Diehl, and known as Singer's (Fig. 1). A short examination of

Fig. 1.



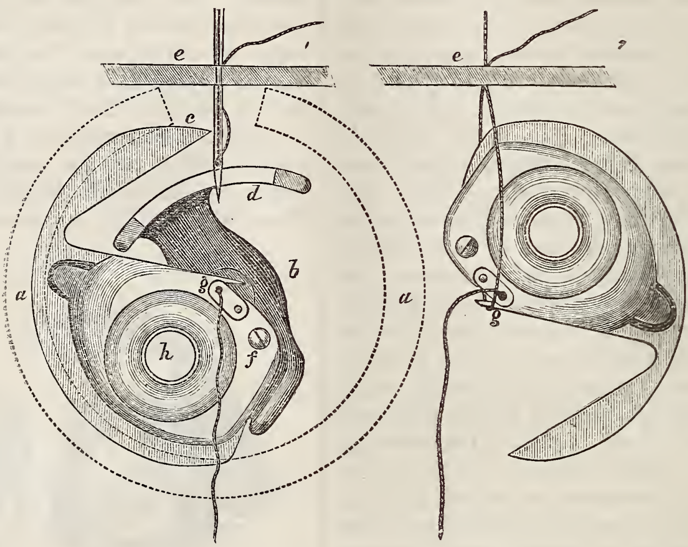
it may profitably engage your attention. The shuttle itself is sufficiently well known, but certain features of it, and to which it owes its efficiency, appear to call for some explanation. Its introduction dates back some years, during which time it has undergone certain modifications.

It consists of a thick disc bobbin of thread, *h*, fitting loosely in a case constructed in the form of a bivalve, *a* and *d*. This case is furnished with a long beak, usually forming a continuation of the periphery. The beak is intended to enter and detain the loops of upper thread, and lead them so that they ultimately envelop the shuttle, a motion of the thread which is chiefly due to the oscillation of the shuttle in a vertical plane. The oscillating movement is to the extent of 180 degs. of the circle, which suffices to cast the loops freely over the shuttle. The centre of oscillation is

not coincident with the centre of the shuttle; but it is nearly so with the periphery of the thread reel, and exactly coincides with the point where the under thread is drawn from the shuttle, *g*. The shuttle thread is thus entirely freed from any tendency to twist, an objection frequently urged against circular or revolving shuttles. It will be observed, also, that the body of the shuttle is extremely narrow. Bulging of the thread loops to one side or the other is thus obviated.

But the long beak in this description of shuttle serves an important purpose other than that of seizing the upper thread loops, otherwise a very short beak would be preferable. It adds so much to the efficiency of the machine that a little further explanation of it appears essential. In the old-fashioned machines the thread required to envelop the shuttle was dragged downwards through the cloth, while the needle still remained in the fabric. This necessitated the use of large

Fig. 2.



needles with deep side channels, to enable the thread to run freely, and as a consequence the punctures that had to be made in the fabric were unnecessarily large, and could not in any case be entirely filled by the thread, a condition which is now recognised as essential in linen stitching and for waterproof boots.

The long beak in both shuttles and hooks offers an immediate solution of the old difficulty experienced with long shuttles. When the needle begins to rise, the shuttle commences to oscillate through the loop, the motions so coinciding that the long beak, *c*, merely detains the loop until the eye of the needle has ascended above the cloth—then, and then only, does the envelopment of the shuttle commence, and the thread required for it flows downwards through the puncture. The envelopment is completed before the needle has attained its highest point, and the consequent loose thread is immediately pulled up by a lever, called a positive take-up, before the needle begins to descend for a fresh stitch. In this way little or no movement of the thread is required in the cloth while the puncture made is occupied by the needle. The result is the capability of such apparatus to work with an incredibly fine needle—indeed so fine as to be no thicker than the incompressed thread itself. This would have been considered quite impossible of accomplishment by our earlier machine makers. The advantage thereby gained in stitching linen goods, and in sewing leather, where every puncture of the needle should be quite filled by the thread, is at once apparent. Indeed, a rubber or leather sack, stitched in this way, will contain water without leakage—a very extreme test.

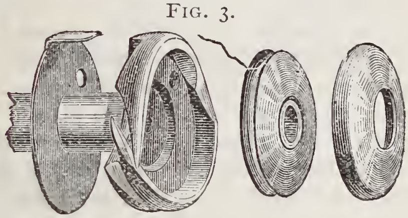
Revolving Shuttles.—The class of shuttles known as revolving or rotating, and which really consist of a combination of the disc shuttle and the earlier rotating hook of Wilson, have been under trial by several makers for

many years. If, for example, the oscillating shuttle we have just examined were to complete its circular movement, it would constitute a revolving shuttle, but would not be quite similar to those devices now known as such. The most remarkable device of this kind yet introduced is to be found in Wheeler and Wilson's machine known as No. 10 D, and invented by Mr. Dials last year. It consists, in fact, of a detached hook, and its inventor declines to class it with shuttles at all, styling it a detached hook. It consists of an exterior shell or skeleton of steel, capable of rotation in an annular race-way. Its detachment from the axis forms a striking exception to the general construction of interlocking apparatus in this company's machines. Under the beak of this curious device is found an oblong recess, into which fits loosely a carrier or driver, rotating with a differential or variable motion. The space between the carrier and the sides of the recess is sufficient to permit the free passage of the thread in encircling the shuttle, and the differential movement ingeniously releases the contact between the hook and carrier. The skeleton of this device is only one-sided, and does not really carry its bobbin in the course of its revolution. The bobbin is placed in a cup-like holder, which lies within the shuttle or hook body, and is retained in position by a latch hinged to the bed of the machine. The cup and bobbin are prevented from partaking of the rotatory movement by a steel spur projecting from the cup, and fitting loosely into a notch in the latch; tension upon the under thread is obtained by passing it under a tension plate upon the bobbin cup. Twisting of the thread is by these means entirely obviated. In this apparatus, the disc-like appearance of the bobbin is partially lost in its considerable breadth, and there is thus a distinct departure from the lines of the ring shuttles before mentioned. The diagrams exhibit the hook in several positions during its revolution, and the position of the threads corresponding thereto.

Fixed Rotating Hooks.—Wilson's rotating hook for lock-stitch machines, and Gibbs' hook for single-thread machines, are both well known. In the year 1872, the Wheeler and Wilson company introduced a new hook, forming an improvement upon Wilson's original device (Fig. 3). Its chief peculiarity consists in the extension of the termination of the periphery, forming a long tail-piece, quite overlapping the point, and serving as a guard, both to keep off the bobbin thread and to prevent collision between bobbin and needle.

This improved class of hooks are provided with a much deeper cavity than those first introduced, an arrangement permitting of the employment of a more commodious bobbin, which is generally covered by a cap, as in the revolving shuttle, but free to revolve. In some cases the cap carries a tension plate preventing its revolution with the hook. But beyond these improvements on Wilson's original device, the utility of the hook mainly depends upon two things quite apart from the hook itself. These are the dispensing with the old-fashioned check brush, and the use of a positive take-up. Thus, in the original machine, the stitch was pulled up by the succeeding revolution of the hook. For, while one revolution sufficed to cast it over the spool, a second turn was requisite to complete the stitch. In this way, to make a first stitch

Fig. 3.



with such an apparatus required two turns of the rotating hook. The improvements mentioned enable the machine to complete a stitch with one turn of the hook—an important step in advance, when we consider that by the old method each length of slack thread must be tightened up solely through the fabric and the needle eye. But this particular arrangement bears so much upon the introduction of the positive take-up itself that further reference to it must be reserved until that device has been described.

Simple Thread Hooks.—The best known of these is Willcox and Gibbs. It has been so often described, that no further reference to it may be made. It continues to make the same excellent twisted stitch as it produced twenty-five years ago.

Of Vibrating Shuttles.—These are shuttles of the long description, moving in a segment of a circle. There are several varieties. The most novel machine of this kind is the vibrating shuttle machine just produced by the Singer Manufacturing Company. In this case the shuttle itself consists of a steel tube, into the

open end of which the wound reel is dropped, and is free to revolve quite loosely. Variation of tension is thus obviated in a very simple manner. The chief point of interest in the machine is undoubtedly the means employed in transferring the motion from the main shaft to the underneath parts, an arrangement as ingenious and effective as any device ever introduced into stitching mechanism. It is the invention of Mr. Robert Whitehill, and consists of a vertical rocking shaft situated in the arm of the machine. Motion is imparted to it by means of an elbow formed upon the main shaft, acting upon two arms, called wipers, projecting from the rocking shaft, the angle formed by the arms exactly coinciding with that of the elbow in its revolution. This admirable motion will no doubt attract much attention from mechanists and engineers.

The Lock-Stitch from Two Reels.—In the early days of the sewing machine, the makers of it often met with the question, "Why do you use a shuttle at all? Can you not invent a method of working from a reel direct?" The questioner generally means a reel placed upon a pin, just as the upper reel is placed. The reply to such a query is, of course, that to produce the lock-stitch in that way is impossible—as indeed it is. But many ingenious machinists have pondered long over the problem, and several clever contrivances have been invented with a view to its solution. It may scarcely be neccessary to say that the best manufacturers of sewing machines have conducted experiments with the same object in view, and the result has always been a return to the shuttle, with its steel bobbins.

Why is this, and how is it that a very big shuttle cannot be used, large enough, indeed, to accommodate any bobbin within itself? The answer is very simple. It has been done over and over again.

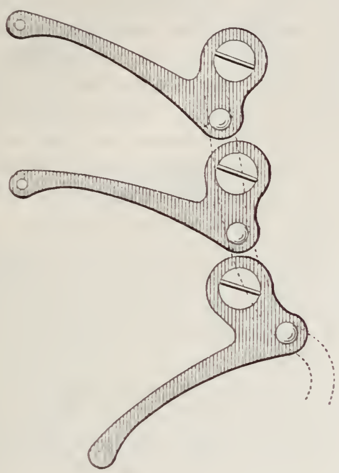
Since the whole bulk of the under thread must pass through the loop of the upper one, it is quite clear that the size of that loop must be proportioned to the bulk of the shuttle. Thus, a small shuttle would, perhaps, be covered by an inch of thread, while our supposed mammoth shuttle might require ten times that amount. Now, let us consider that to sew an inch of thread into look-stiches frequently involves its being drawn up and down through both needle and fabric twenty times. This means considerable chafing, and possible injury to the thread. But if we were to sanction the use of capacious shuttles, ten inches of thread must undergo this chafing and seesaw treatment, and under the above conditions every part of the ten inches must pass up and down two hundred times—treatment that might reasonably be expected to leave little "life" in the thread. But in spite of this tremendous drawback, there are machines offered for sale made with such shuttles.

For reasons that I have now pointed out, it is quite clear that a large shuttle or bobbin is by no means an unmixed advantage. Indeed, the very best makers of sewing machines have always striven to keep down the bulk of the shuttle, and in those splendid machines shown here to-night, the use of the small shuttles is conspicuous. It may be contended that small bobbins frequently require refilling, which is quite true, but the saving of the thread effected thereby, not to mention that of the machine itself, amply compensates for the use of small shuttles. Apart from this, however, it is no longer necessary to wind bobbins at all. Dewhurst and Sons, of Skipton, and Clark and Co., of Paisley, have produced ready wound "cops" or bobbins of thread for placing direct into shuttles. Thus no winding of bobbins is necessary, and indeed the bobbins themselves are dispensed with. I believe that the slightly increased cost of the thread thus wound is the only present bar to the extensive introduction of ready wound "cops."

Of Thread Controllers.—One of the earliest difficulties encountered by the maker of a sewing machine was that of effectually controlling the loose thread after it had been cast off the shuttle. In some machines this slack thread amounts to six, in others to one or two inches. Howe got over the difficulty by passing his thread, on its way to the needle, over the upper extremity of the needle bar—the ascent of the bar, then, sufficed to pull up the slack. Singer improved upon this by furnishing his machine with a spring take-up lever, partially controlled by the needle bar. Wilson, in the Wheeler-Wilson machine, had neither of those arrangements, but depended upon the succeeding revolution of the hook to draw up the slack of the preceding stitch. These devices were all far from perfect in their operation, chiefly because they commenced to act too soon. In each case the pulling up commenced with the rise of the needle, and the tightening operation subjected the thread to all the friction of rubbing its way through both needle-eye and fabric. Now, an ideal take-up should not commence to act until the needle has ascended above the fabric, and one

of the most important steps towards perfection in sewing machines was undoubtedly attained when such a device was actually invented. In effecting this, the means employed consists of a differential or variable cam, rotating with the main shaft. This controls the movements of a lever called the take-up, pivoted to the machine (Fig. 4). Not only

FIG. 4.

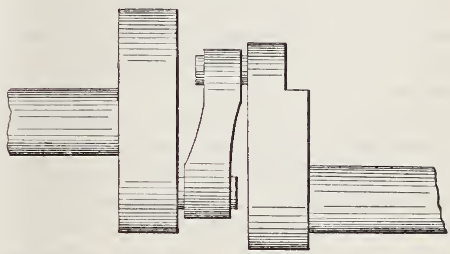


has it been possible by these means to control the tightening of the stitch, but the paying out of the thread for enveloping the shuttle also, and both the paying out and pulling up are actually effected after the needle has ascended above the cloth. The introduction of the positive take-up, the first forms of which appeared in 1872, not only simplifies the movements of the shuttle or hook, but for the first time renders the making of the lock-stitch possible, while the needle has a direct up and down motion. Thus, we find that in most of the swiftest sewing machines, the needle-bar is actuated by a simple crank-pin or eccentric, there being no loop-dip or pause in its motion.

The diagram shows a positive take-up in three positions; at the commencement of the needle's descent, during the detention of the loop by the beak, and during the casting off of the loop. The dotted lines indicate the path of the cam to produce these positions. The intermittent movements of the take up have thus led to the abandonment of variable motions in both needle and shuttle, and particularly so in oscillating shuttle machines.

Wheeler and Wilson's Variable Motion.—But while the simple and direct movement is now preferred for shuttles, both oscillating and rotary, the revolving hooks of Wheeler and Wilson are provided with a differential motion, and the way it is effected appears sufficiently interesting to call for a short description. When the rotating hook has seized the loop of thread, it makes half a revolution with great rapidity; its speed then slackens, and becomes very slow for the remaining half a revolution. In the first machines introduced this was effected by means of a revolving disc, having slots in which worked pins attached to the main shaft and hook shaft respectively. In the later and more improved machines the variable device is much simplified (Fig. 5).

FIG. 5.



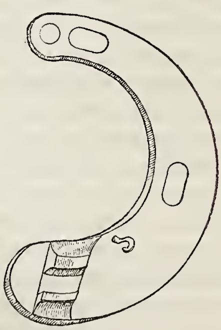
The main shaft, leading to the rotating hook, is separated into two portions, the axis of one portion being placed above that of the other. A crank-pin is attached to each, and these pins are connected together by a simple link. An examination of the device itself shows that, while the motion of the main shaft portion is uniform, that of the hook shaft is alternately accelerated and retarded. The picture on the screen gives a general view of the No. 10 D machine, in which these motions are embodied, and showing the position of the positive take-up affected by those motions, a position which is preferred for very high speeds in this machine, especially for threads possessing little elasticity.

Motions of the Feeder.—The speed attained by the fastest sewing machines is due more to the reduction and simplification of the movements than to any other improvement. Heavy concessions and reactions have been replaced by direct motions, and cams have been excluded as much as possible. Mr. A. B. Wilson's famous invention of the four-motion feeder depended upon both gravity and a reacting spring for two motions. Singer improved upon it by making three of the motions positive, a spring being used for the drop. But a really positive four-motion feeder was long sought by inventors. Hitherto the reaction of the feeder—that is, its descent and

recession—was generally attained by means of a spring. The drop and ascent are now effected by means of a separate eccentric in Singer's machine. Uncertainty of action in the feed, once a cause of much inconvenience, may now be said to be overcome. A peculiarity of the four-motion feeder in Wheeler and Wilson's machine is an arrangement enabling the operator to feed in either direction at will.

Not less worthy of note are improvements that have been made in wheel-feeders. The wheel-feed was originally much used for cloth sewing machines, especially in Singer's system; but in recent years the drop or four-motion feeder has entirely superseded it for such purposes. The wheel-feed still holds its own, however, for sewing leather, especially in the "closing" of boot uppers, in this country. Singer's original wheel-feeder was actuated by a friction shoe riding upon the flange of the wheel. The friction grip, however, had certain faults, owing to the tendency of the shoe to slip when the surfaces became covered with oil. A later form of Howe's machine used a pair of angular clutches, embracing the flange of the wheel. In both Singer's and Wheeler and Wilson's latest styles of machines this arrangement is simplified and improved by the use of a single angle clutch, which is found to work even when the surfaces are freely oiled (Fig. 6).

Fig. 6.



Any motion of the free extremity of the lever upon which the biting clutch is formed binds the latter upon the flange of the wheel, which then advances so long as the lever continues to move in that direction. When the stitch is completed, the clutch is allowed to recede, and is pulled back by a reacting spring. The bite of the clutch is given by the two opposite corners.

The feed-wheel itself is free to revolve in a forward direction, but is prevented from rocking backwards in Singer's machine by an ingenious little device, recently introduced. It consists of a small steel roller, situated within the angle formed by an inclined plane and the flange of the wheel, and constantly pulled into the angle by a spiral spring. Any backward tendency of the wheel binds the roller more firmly in the angle and stops the wheel. Former feed-wheels were checked by a brake spring or block, which retarded the motion of the whole machine when heavily adjusted.

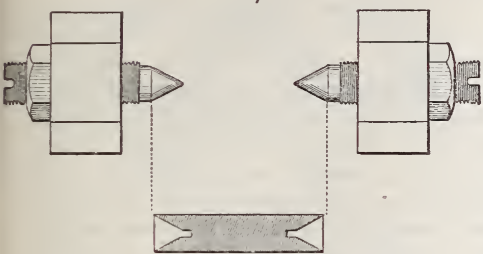
Feeders for button-hole sewing machines are almost invariably of the wheel type, but in this case the cloth is usually carried by a clamping device, and moved in a pear-shaped path by means of a cam cut in the feed-wheel, as shown in the samples of this wonderful kind of mechanism exhibited here to-night.

The Compensating System of Construction.—Compensation for wear is a part of the mechanist's art that appears just as essential to him as compensation for variation of temperature are to a maker of chronometers. In the construction of sewing machines to be run in factories by power at their utmost speed, such a system is of the greatest importance. An effective *system* of compensation has been eagerly sought by the best machine makers ever since the introduction of fast-speed sewing. Compensation has been attempted here and there in the machines for many years, but no sewing apparatus could be said to be so compensated until the cone compensator came into use, a device which has been taken advantage of by various makers. Save in the shuttle race itself there is not a part of the oscillating shuttle machine subject to serious wear that cannot be instantly adjusted to full motion by the turning of a screw, while wear in the shuttle race can be compensated for in the usual way. This effective system depends upon the union of two mathematical forms, long used in mechanism—the *cone* and the *screw*. In screw-cones we possess a perfect compensator, and it is surprising that parts of mechanism so hung appear subject to very little wear. Another advantage, too, is gained by the introduction of screw-cone bearings; the friction is always greatly reduced by their use. In every case the fine adjustment of the cones is securely maintained by lock-nuts (Fig 7, p. 339).

But the screw-cone system is not the only compensator used in sewing machinery; where it cannot be easily introduced, other devices

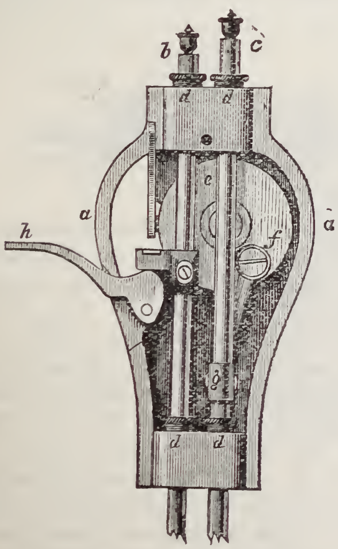
have been employed. The well-known tapering needle bars of former years have been superseded by cylindrical needle-bars. The Wheeler and Wilson Company appear to be the first who utilised the engineer's shifting box as an anti-friction device for round needle-bars. They packed their bars round with felt rings,

FIG 7.



and compressed the whole by a screw-cap. In the Singer machines the same excellent device has been adopted, hemp packing and screw bushes being used (Fig. 8). *f* and *g* show the direct action on the needle-bar. This method of forming needle-bar bearings, partially of metal and partially of felt or hemp, has afforded ths most surprising results.

FIG. 8.



When the bars are of hard or finely-polished steel, no perceptible wear can be detected in them, even after they have been in daily use in factories for twelve months, whereas bars not so bushed might show considerable wear in that space of time. The packing, to be effective, should be sufficiently close to prevent as much as possible friction of the steel with the cast-iron needle-bar ways. Lubrication of the steel is ensured by keeping the hemp packing moistened with oil.

Cylindrical needle-bars, when combined with an effective system of brushing, have proved themselves superior to every other form of slide for lock-stitch machines. But their introduction is by no means a thing of yesterday. They were used freely in sewing machines as far back as 1860, but were never very successful until united with the lubricating brush. Some makers go a step further, and elaborate the system by the introduction of steel brushes, easily renewable.

Every effort is now made to reduce, as much as possible, not only the extent of movement of the parts in high-speed machines, but the weight of the parts themselves; indeed, so far has this been carried that, in some of the Wheeler and Wilson machines now shown, the needle-bars consist really of steel tubes. Small moving parts are made as light as possible, but rigidity is secured by the free use of strengthening ribs. Many of the parts are of cast iron, rendered malleable by annealing, and, finally, case-hardened. Such parts are found to be quite as durable as if made of forged steel, and are, of course, less costly. As to the automatic tools now used in the construction of the machines, it may be said that scarcely a file, hammer, or chisel touches the frame or parts while they are being assembled to work together. The interchangeable system of construction is, of course, the only one possible for the accurate production of the millions of sewing machines now manufactured annually.

High Arm Construction.—Sewing machines, as now constructed, exhibit a rather short and very high arm, a form of framework that has been found to contribute in no small degree to to the light running capabilities of fast-speed machines. While it reduces the length of the various parts concerned in the transference of the motive power, it adds to their rigidity and diminishes their weight, maintaining at the same time the capacity of the machine to accommodate the largest garments beneath the arm.

But the specific improvements in plain sewing machines to which I have had the honour of drawing your attention do not exhaust the list, and, time permitting, it might be considerably augmented. Nor must it be inferred that advancement has taken

place exclusively in those systems of sewing machinery now before us.

Accessories to Sewing Machines.—The number of special attachments that have been successfully adapted to plain sewing machines has multiplied so rapidly of late, that only one or two of the more notable can be spoken of on this occasion. Perhaps the most generally useful of these is the trimmer, an arrangement consisting of a vibrating knife, which trims off the superfluous edge of a seam as the machine stitches it. These are in extensive use in the factories at Leicester, Nottingham, and elsewhere, while Northampton and Norwich use the same device for paring the seams in boot-upper manufacture. The chisel-like knife is usually actuated by a cam rotating with the main shaft, and one or two of the usual forms of this attachment are to be seen here this evening on both lock and loop-stitch machines.

When machines are moved by the foot, there are many objections to running the whole machine while winding the shuttle reels. We have, therefore, several useful devices for releasing the balance wheel of the machine from the main shaft, while winding. These are to be found both on Wheeler and Wilson's manufacturing machine, and upon Singer's highly finished "family" machine, which also carries a most ingenious automatic reel winder, capable of doing all the work itself, and ceasing to act as soon as the bobbin is filled.

The setting of the needle in a sewing machine was once quite a task. Ofttimes it had to be adjusted by chance, in other instances by certain guiding marks upon the needle-bar. It is gratifying to know that all this has been done away with, and that the needle has only to be inserted into the bar, and fastened by turning a small screw. These are styled self-setting needles, and are usually so arranged that they cannot be adjusted wrongly as to the position of the eye.

In the Willcox and Gibbs machine, and in Singer's single-thread machine, shown here, we have an intermittent tension arrangement, which clamps the thread at the right moment, and differs from ordinary tension devices, inasmuch as it may be said to be automatic. The feeder, too, on these machines is of excellent design, while the arrangements that have been introduced into the Willcox and Gibbs straw-hat sewing machine are surprisingly effective in spinning up a hat from a loose roll of braid. Speaking of straw-hat machines, mention should be made of Wiseman's hand-stitch apparatus, as improved by Messrs. Willcox and Gibbs, and shown here this evening. This machine employs two needles, and makes a stitch resembling hand-work at intervals, producing a short stitch at the centre of the hat, and automatically widening the space between the stitches as the distance from the centre increases. The machine itself is of wonderful ingenuity, and must be examined to be understood.

The stitch-making itself is, I believe, quite new, and is also of much interest. A pair of needles, the width of a stitch apart, rise from beneath through the material; one of these is an ordinary machine needle, threaded; the other is a barbed needle. After rising above the surface, the loop of the threaded needle is seized by a "threader," and thrown into the barb of the barbed needle. The needles then descend, and the feed occurs, being the length between stitches. Upon the ascent of the needles again against the material, the loop is both given off the barb, and is entered by the threaded needle, completing the stitch.

Of Button-hole Machines.—The mechanism of button-hole machines is so intricate, that I can only attempt on this occasion to partially elucidate the construction of one of them, recently introduced, namely, Singer's, which automatically cuts, guides, and stitches the work.

Fig. 9.

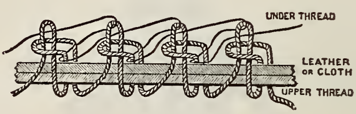
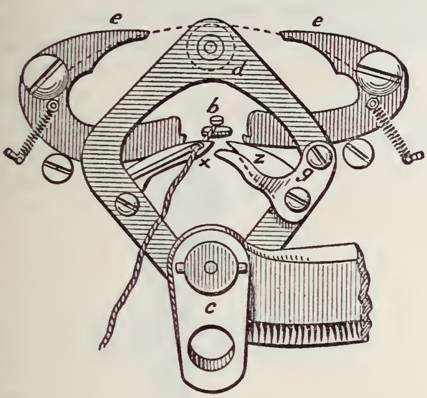


Fig. 9 exhibits the stitching made by this machine upon the edge of the button-hole. Fig. 10 represents the right and left-hand oopers and loop spreaders, and for the stitch-making. They rock from right to left with an intermittent motion obtained from a cam. The left-hand looper carries the under thread and interweaves it with the upper, forming the stitch, originally invented, I believe, by Mr. George Fisher, of Nottingham, and re-invented for the button-holing machine by D. W. G. Humphreys, of Massachusetts, U.S.A., in 1862. The loop spreaders are moved by a roller carried upon the looper frame. Fig. 11 exhibits the feeding arrangement, both sides of the feed-wheel, the driving lever and the shape of the path given to the carrying clamp by the heart cam cut in the upper surface of the feed-wheel.

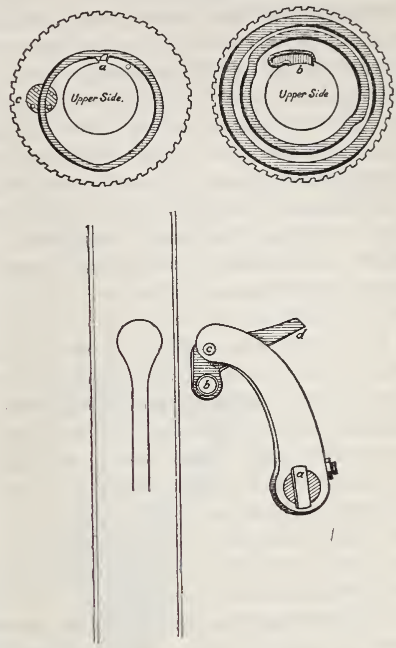
The picture on the screen represents the upper portions of the machine, exhibiting the conveying clamp, the to and fro dipping motions of the needle-bar, and the parts conveying motion to the arrangements beneath the bed-plate. These are shown in Fig.

FIG. 10.



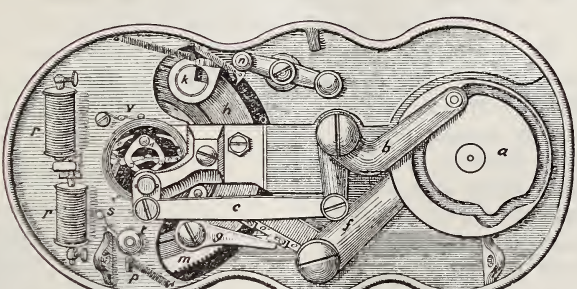
12, and represent the feed and looper cams, the feeding and looper levers, and the stitch-forming mechanism already shown. A most ingenious device in this machine is the arrangement for automatically lengthening the throw of the feed while stitching around the eye of the button-hole. It is effected by means of a cam, which imparts more or less leverage to the feed-arm by the intervention of a "shipper" lever, hinged to the feed-lever itself. The space of time at my disposal obliges me to recommend a personal

FIG. 11.



examination of the machine itself, to fully understand its various motions and its action in working a button-hole.

FIG. 12.



Mention may be made of Singer's special button-hole machine for making the straight holes used in linen work, and in which a shuttle is employed. Of Wheeler and Wilson's ingenious button-hole machine for the same purpose, I am enabled to show a diagram, in which it will be observed that the feeding arrangements are placed above the bed-plate, and are no doubt thereby rendered easily accessible.

Application of Power to Sewing Machines.—There was a time when a cry arose to the effect that the introduction of mechanical sewing would lead to divers calamities, physical and mental. The ladies were to become crooked in the spine, and regular operators

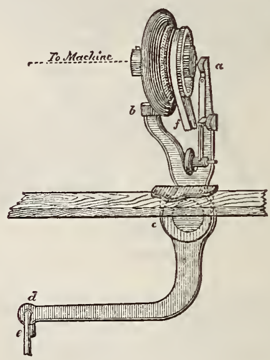
were to become regular cripples. It is scarcely necessary to ask, has this been so? The operators of to-day are, I think, superior in physical attainments to their sisters of the needle and thread fifty years ago.

Within the past few years a revolution has taken place in the moving of sewing machines. Domestic machines will probably always be driven by foot power; spring, electric, and water motors notwithstanding. But the age of treadles in the great manufacturing trades is a thing of the past. It was not necessary for Parliament to step in and protect the workers, as was frequently suggested by alarmists. The commercial interests of manufacturers themselves were at stake. Machines driven by power could do 25 per cent. more work than those moved by foot. The operators, relieved of the treadling, maintained a much better working condition; and altogether the introduction of power driving, once well tested, became a necessity. Power sewing machinery was speedily devised and introduced by several of the first mauufacturers, controllers of the speed of the machines followed, and two or three splendid systems of stitching by steam power were soon widely known.

By the kindness of three of the best manufacturers of power sewing machinery, I am enabled to show to you, this evening, the best-known systems, arranged just as they are fitted in many large factories, as also a sketch of the arrangements of Wheeler and Wilson's system. We have, in the first place, a light shafting carrying a band wheel opposite to each machine. By the use of a powerful electro motor, the shafting is caused to rotate at the rate of 400 revolutions per minute by electricity. The current is generated by the Society's dynamo machine, and is conveyed here by copper cable. I do not know of any instance of sewing machinery in a factory being driven by an electro motor, but such means of conveying motive power appears admirably adapted for that purpose, when the stitching room happens to be far removed from the main shafting or engine. But with regard to motors for sewing machines, when special power has to be fitted down for that purpose, my own experience leads me to speak in favour of the admirably-governed "Otto" gas-engines made by Crossley Bros. These are especially steady, a feature of no small moment in moving stitching machinery of various kinds.

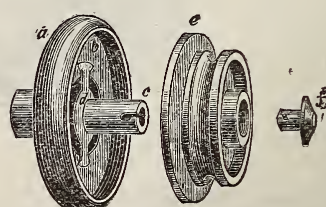
Much attention has been devoted to the invention of controllers of the motive power supplied to sewing machines. The principle of the friction disc has found most favour. In many cases two of these plates, fast and loose, are placed upon the main shaft, and their separation and contact controlled by the treadle. The great sensitiveness of the friction attachment employed by the Singer Company is due chiefly to the transference of the friction plates to the axis of the machine itself (Fig. 13). Their contact and separation

Fig. 13.



are controlled by a lever worked by a very slight movement of the treadle. But the chief point of interest in this device lies in the combination with the lever of a brake, enabling the operator, by a simple reversal of the treadle's motion, to instantly suspend the rotation of the machine. The forked lever, in fact, acts simultaneously in throwing off the motion and applying the brake. The speed is always in direct proportion to the pressure exerted upon the treadle, and a single stitch can be made at will. Fig. 14 shows the friction

Fig. 14.



wheel separated, the portion *a* being fast, and *e* loose.

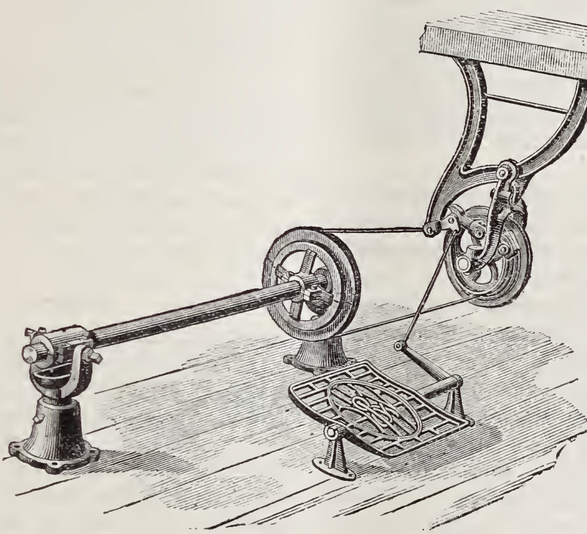
The Wheeler and Wilson Company do not confine themselves to any particular controller, but prefer the form shown here this evening

(Fig. 15), in which two bands and an intermediate pulley are employed. The first band is left rather loose, and the machine is set in motion by the tightening of this band through the depression of the treadle. The speed varies in proportion to the pressure applied, and the sensitiveness of the arrangement is increased by a brake device coming into play by the reversal of the treadle as before.

Messrs. Wilcox and Gibbs depend upon a similar device shown in three varieties to-night.

Speed of Power Sewing Machines.—The fastest practicable speed of a machine worked by the foot appears to be 1,000 stitches per minute. Most operators can guide the work at a much higher rate, especially in tailoring or on long seams. The average speed upon such work is 1,200 stitches per minute; but many lock-stitch machines are run at 1,500 and 1,800 per minute, and even at much higher rates. There is always a limit to be imposed upon speed by the guiding powers of hand and eye; it is this limit, and not the capability of the machine, that confines the rate of driving. Willcox and Gibbs' single-thread machines are run in many instances at 3,500 stitches per minute. We have before us a single-thread Singer machine (appropriately named the "Lightning Sewer") and a Wilcox machine, moving at the enormous rate of 4,500 stitches per minute, and producing good work. But it is doubtful whether such very great velocities can ever be advantageously employed. Upon collar work, and in sewing boot uppers, the rate seldom rises above 1,200 with advantage. If the machines be speeded too high in any trade, the operator never uses the excess, and it only proves a drawback. I have seen the heaviest and hardest kind of navvy boots stitched at 1,500 to the minute upon Singer's lock-stitch machines. Wheeler and Wilson's No. 10 D machine has been run by them, I am informed, as high as 2,500 to the minute. Loop-stitch machines, when well made, can be actually run as high as 6,000, but 4,500 is, I believe, the maximum yet used for this class of machine, even experimentally. There can be no doubt that lock-stitch machines can be run as high as 3,000. The actual speeds of the lock-stitch machines shown here upon the power stand averages 1,300; those of the chain-stitch machines varies from 1,200 for the sack-sewing machine, to 4,500 for the small or single chain-stitchers. Any of the latest styles of either lock-stitch or single-thread machines can be run far faster than any known expert operator can possibly guide the work under it. It is very improbable that such speeds will ever be exceeded. The limit has no doubt been reached. Very high speed is generally a delusion, and either results in indifferent work, or actually retards its progress. Some idea of the speed of the single-thread machines

Fig. 15.



now shown may be gathered from the fact that, running at 4,500, and making eight stitches to the inch, they accomplish over fourteen yards of sewing every minute.

Of special machines of interest, and which are too unwieldy to be shown here, I am enabled to exhibit a few photographs. One of the most novel of these is the "Twin" machine, designed by the Singer Company for the connecting together of the Jacquard cards used in lace machines. The operation was formerly performed by hand. It is now done by machine at less cost. The cards are placed upon a feeding drum, and fed beneath a pair of needles. The laces forming the connection between the cards are fed above and beneath, in line with the needles, and the whole is easily stitched together. An extension of the same device is the multiple machine, in which four needles and shuttles are used, sewing all the four seams at one operation. This method of linking the cards is considered better than similar work done by hand.

Of Wheeler and Wilson's new factory at Bridgeport, and of the Singer Company's great new factory, near Glasgow, I am enabled to exhibit photographic views.

Before drawing my remarks to a close, I would briefly indicate the nature of the various machines shown upon the power benching. Of the Singer system, there are four. A drop feed oscillating shuttle machine for manufacturing purposes; a wheel-feed oscillating shuttle machine, furnished with a trimmer, used chiefly in stitching leather and boot uppers; double chain-stitch machine, used for sack making, now shown for the first time; and a single-thread "Lightning Sewer," fitted with a trimmer for hosiery work. Of Wheeler and Wilson's system, there is a drop-feed manufacturing machine with the new detached hook and latest improvements; a No. 10 machine with the usual hook, a wheel feed and trimmer, and a smaller machine of the same type with drop-feed. Of Willcox and Gibbs's system there is the ordinary single-thread machine for manufacturing, a single-thread machine, with a trimmer, as used in the hosiery trades, and a machine specially used for straw hat making.

We have here a small Singer machine, riding upon the edge of two pieces of carpet, a carpet machine weighing ten pounds. When the handle is turned, it stitches and travels over the edges, uniting them faster and more securely than six hand sewers; and several others, representative of the family type of sewing machine, besides Wheeler and Wilson's hem-stitch machine, the working of which is of much interest.

I would now invite those of you who seek a better acquaintance with those curious and novel machines to freely examine and test the various types to be found upon the power benching and upon stands. One or two operators will come forward and show some of the capabilities of the machines upon actual work, in which the making of a straw hat will perhaps show what can be done in a few minutes by quick speed and expert fingers, but these performances must not be regarded in the light of competitive tests between the manufacturers showing them, and are intended merely to show the utility of motive power driving.

In conclusion, I desire to thank those gentlemen at the head of the leading firms of sewing machine manufactures for the trouble they have taken to arrange for your inspection specimens of their excellent systems, and I have much satisfaction in expressing my obligations to them for ready assistance in the preparation of my paper.

Power machines and treadle machines were exhibited by Messrs. Willcox and Gibbs, Messrs. Wheeler and Wilson, and the Singer Manufacturing Company. The motive power was provided by an electrical motor, supplied by Mr. Moritz Immish. The Howe Machine Company exhibited a model of the first machine made by Elias Howe, and also one of the most recent Howe machines. Mr. Newton Wilson showed a model of the Saint Sewing Machine, constructed from Thomas Saint's patent specification, 1790, and Mr. Carver showed the Standard Sewing Machine.

DISCUSSION.

Mr. Alfred Carpmael said his experience was not so much with regard to improvements in sewing machines during recent years as of sewing machines as they were twenty years ago; but what struck him most in the paper was, that though nothing ought to be considered small or trivial, yet most of the matters brought forward to-night appeared, taken singly and individually, to be of itself small. Twenty years ago there were machines with straight needles making the same stitch they did to-day, and also feed-motions which fed the work forward, and answered the purpose; and yet they were told that all those machines had dis-

appeared, and would have no chance of being sold if produced to-day. What were these changes which had been introduced? The first, and most important, was what was called the positive take-up, and a most essential thing it was in a sewing machine, because if the slack given off from the shuttle were not taken up, the thread got into all sorts of extraordinary places where it was not wanted, the shuttle did not catch the loop of the upper thread, and you did not get a perfect stitch. The next thing which seemed of importance was a device for counteracting wear, to be able to adjust the wearing parts, and that was obtained by applying to the shaft the ordinary back centre of a lathe, so that if any wear took place, by turning a little screw you brought a new surface to bear. There were no doubt many other improvements, but having no recent experience of these matters, he would not attempt to go into them. But as an Englishman, he must disclaim any credit for this country in the invention of the sewing machine. Mr. Urquhart said he did not know whether this credit belonged to America or England; he believed there was a claim put in by France; but it certainly did not belong to England, for the first machine ever seen in this country which was capable of sewing a garment certainly came from America.

Mr. J. C. Chaplin said he was connected with the Howe Sewing Machine Company, and he regretted he had not had an opportunity of conferring with Mr. Urquhart before his paper was finally settled, as he should have liked to call attention to the progress made by the company with which he was connected. He had, with the permission of the Council, brought the original machine invented by Elias Howe, which might be interesting, though of course he did not suggest that it was capable of making 6,000 stitches a minute. Many of the things brought forward to-night were quite new, and perhaps some might be ephemeral; and he doubted whether many persons present had been able to realise and understand the technicalities which had been put before them, though many would be able to do so much better when they read the paper quietly at home. He regretted that they had not heard more of the solid advantages which had resulted from the labours of others besides the two or three who had been specially referred to. There were firms in England, Bradbury, Jones, and others, who had introduced important improvements of which they had heard nothing. Messrs. Singer, and Wheeler and Wilson, and Willcox and Gibbs, they had heard a good deal of, but he thought it would have been more useful if Mr. Urquhart had given as the result of his experience, apart from the machines exhibited, what were the three or four leading alterations and improvements which had occurred in the manufacture of sewing machines, and which were now well established. One subject he had touched upon very lightly which was considered very important by many, viz., that there should be some device by which people might be able to take two reels of cotton and sew away at once without having to reel the cotton in one case on to a little bobbin to be placed in a shuttle. This was partly accomplished by having the cotton supplied ready wound for placing in the shuttles, but that was tried years ago and did not succeed, and he doubted if it would succeed now. The great desideratum was to have an effective machine which would utilise two reels of cotton. A German firm had introduced a machine which would do this, but it was rather a cumbrous arrangement. The introduction of the radial shuttle race instead of the simple straight shuttle race was a great improvement; that had been done by White, Horne, and several others, including Howe. The Wheeler and Wilson principle was the same, and for many years that firm had made most excellent machines, though they had not indulged in so many novelties as Messrs. Singer and Co. What was still known, however, as the Singer system, he believed, still formed the solid part of their business, and he doubted whether many of these novelties would last ten or twenty years as the original machine had.

Mr. Newton Wilson said he had been connected with sewing machines for a longer period probably than anyone present, and could look back much further than Mr. Urquhart. Some of the novelties now described he recollected being in use twenty years ago. One of them he himself applied to the Singer machine twenty-two years ago, when he was being sued by them for an infringement of their patent. His memory went back further than Mr. Carpmael's, and he must inform him that there was no longer any doubt where the original idea of the sewing machine had birth. In a specification in the Patent-office for boots and shoes, dated 1790, he discovered, some years ago, a drawing of a complete sewing machine, together with drawings of other machines, showing wonderful ingenuity on the part of the inventor, who was a London carpenter, Thomas Saint by name. Being much interested in this matter, he made a model from the drawing, which was exhibited in the Centennial Exhibition in Philadelphia, in 1876. He had had it brought there that evening, and an examination of it would show how many of the modern improvements had been anticipated, fifty-six years before the time of Howe, and forty-four before the time of the Frenchman, Thimmonier. The feed was performed by a slide-rest motion, there was the straight needle on the line of Howe, and the very modern invention of a separate awl to bore the hole, while the needle followed with the thread at the next operation. He desired to bear testimony to the amount of patient research which Mr. Urquhart had bestowed on this matter, and the admirable manner in which he had illustrated modern inventions deserved high praise; but the subject had not been treated in so comprehensive a manner as he could have wished. Wheeler and Wilson had received fair recognition,

and Willcox and Gibbs also, but of all the other numerous houses and inventors—English, French, and German—who had contributed to make the sewing machine what it was to-day, they had heard practically nothing. It would be only fair that some notice should be taken of these people, and particularly of what our German rivals had effected. One firm had been referred to by Mr. Chaplin as having introduced a machine in which the spool was used intact. He had not seen it. They said it was perfect, and he could not say it was not. But Mr. Urquhart said it could not be that such an invention could succeed. But this was an age in which an impossibility only meant something not yet accomplished, and he yet hoped that it might be done. He knew it was attempted twenty years ago, and he had such a machine, though it was not a success, and perhaps might not be yet. Many other inventions might have been referred to, and as he had thought it possible that the latest might not have been mentioned, he had brought it in his pocket—the Moldacott. This machine was very well adapted for the amusement of children in making dolls' clothes.

Mr. J. L. CARVER remarked that though the past history of the sewing machine might be interesting, the great question for practical men was as to the future—what was to be the system or plan adopted in mechanism for sewing? They had seen various kinds of shuttles, and probably there must always be chain-stitch and lock-stitch machines, but the main question, to his mind, was what was to be the mechanism for the lock-stitch? Was it to be a revolving shuttle with two revolving shafts, or one revolving shaft and a revolving shuttle, or an oscillating shuttle? Those were the questions on which a skilled opinion would be valuable.

Mr. R. J. JOHNS inquired whether the needle would not become very hot at the enormous speeds which had been mentioned.

Mr. URQUHART, in reply, said this subject was such a comprehensive one, that it was utterly impossible to deal with it thoroughly in one paper. Reference had been made to English improvements, but these had been very few, indeed, of late years, not so much for want of ingenuity, as on account of the state of our Patent-laws. American inventors appeared to be encouraged in every kind of way, but English inventors had not been able to bring forward their ideas; but no doubt many of the clever contrivances he had shown found their way to the States from this country, and were brought out there under more favourable auspices. They had been told that several of these American devices were of a trifling description; but it seemed to him that the sewing machine was made up of trifles, and if you abolished all the trifles, you would have to do away with the machine altogether. The prominence given to Singer and Co.'s improvements arose only from a sense of fairness, for they were more in number than could be assigned to any other firm. The Singer Company appeared to have devoted attention to points which had escaped the notice of many others. One gentleman had expressed a desire that the Junker and Ruh machine would prove a success, but he was afraid that that device, which was very old, never would be successful. No doubt the German machine referred to was the best thing which had been done in that way, but the principle of involving the whole under thread in one shuttle could never be attained in practice in high speed machines, owing to the length of thread which had to see-saw up and down through the needle. The Moldacott machine was a beautiful little toy, but it scarcely came under the description of a machine for manufacturing purposes. The question of the future of sewing machines opened up a vast vista of possibilities, for he considered they were as yet only in their infancy. As to the heat developed in the needles driven at these enormous rates, he could only say that it would depend on the amount of friction developed in the fabric; with a soft fabric there would be very little heat, but with a hard fabric there would be a great deal, and no doubt the needle would become red hot in a very short time. Of course, such a speed as 4,000 stitches a minute was only experimental; it could be seen there that evening, but it would be absurd to speak of such speeds in practice. No operator could work at such a speed.

The CHAIRMAN then proposed a vote of thanks to Mr. Urquhart, which was carried unanimously.

The various machines exhibited were then put into operation.

Miscellaneous.

THE IMPERIAL INSTITUTE.

The following is an official statement of the progress made up to the present time towards the establishment of the Institute:—

"The official approval of the report made, under date of December 20 last, by the Organising Committee nominated by his Royal Highness the Prince of Wales, was speedily followed by active measures of organisation for securing public subscriptions throughout the country. The introductory step in this direction was the holding of two great meetings, one at St. James's Palace, the other at the Mansion-house, London, on January 12, at which the scheme and objects of the Institute were described. The organising staff, under the direction of Sir Frederick Abel, C.B., D.C.L., F.R.S., then at once commenced its operations. Since the meetings re-

ferred to, communications have been addressed, in the name of the Prince of Wales, to over 3,000 public officials, including the Lords Lieutenant of every county, the mayors of all cities and boroughs, the chairmen of local board townships, and the chairmen of boards of guardians and Scotch Poor-Law combination boards. The Poor-Law authorities were addressed with the object of securing the co-operation of those gentlemen representing rural parishes not comprised within the limits of any city, borough, or township. Letters have also been sent to, and encouraging acknowledgments received from, the presidents and members of various scientific, legal, and technical societies. The Council of the Society of Arts was the first to respond actively to an invitation to co-operate in the collection of subscriptions, with most satisfactory results. Down to the present date the replies received to the inquiries made of the various authorities in the United Kingdom have been of the most assuring character, 90 per cent. at least returning favourable answers to the suggestions made to them in respect of the formation of local committees or the adaptation of existing local organisations with the object of securing subscriptions to the Institute Fund. So far, the advices to hand show the result of the last six weeks' work to be that more than £50,000 is already available within the United Kingdom for the work of the Institute. In this statement no account whatever is taken of official and private contributions from India and the Colonies, it having been thought better to defer the publication of details from those portions of the Empire until the absolute particulars can be given. It may, however, be stated that the letters from the Colonies and India, and particularly from the latter dependency, are of the most satisfactory description. There would seem to be on every hand clear indications that the national memorial, originated by the Prince of Wales, and declared by Her Majesty to meet her special approval, is commending itself generally to the Queen's subjects throughout her dominions. Forms of reply are being daily received in large numbers from every part of the country, and the details of localities and jurisdictions within which the committees have been formed, or are in process of formation, amply testify to the ready and cordial manner in which the project is being viewed in the provinces. The result of the organising appeals in Ireland is not so favourable as could be desired, but even in that country active efforts are being made in many quarters to insure that portion of the United Kingdom bearing its part in the establishment of the Institute."

On Tuesday last the Mansion-house Committee, recently formed by the Lord Mayor for aiding the Imperial Institute scheme in the city of London, held its first meeting in the Venetian Parlour, with the Lord Mayor in the chair. It was resolved unanimously, on the motion of Sir John Lubbock, M.P., seconded by Mr. Walter Leaf, "That subscriptions be invited to the Mansion-house Fund in celebration of Her Majesty's Jubilee, such fund to be devoted (unless where otherwise directed by the donors) in the proportion of 70 per cent. to the Imperial Institute, and 30 per cent. to the Museum in the City, or such local object as the Mansion-house Committee may hereafter determine."

Correspondence.

PURITY OF BEER.

I beg for permission to answer a statement made in the paper of Mr. Salamon on the purity of beer.

My acquaintance with the subject of the impurity of beer has been mainly in connection with the Adulteration of Foods Act, and I have no reason to alter a word that I have written.

Mr. Salamon admits that, "if water, or sugar and water, be added to beer, unless it be done with the greatest skill and care, it will nullify all the efforts of the brewer, and will convert his product into what is commonly known as swipes." Again: "Now, there is no good in blinking facts, and however unpleasant the statement may be, there is no doubt that many publicans do tamper with their beer."

Well, then, if, as Mr. Salamon says, he has no hesitation in stating it as his opinion, that the complaints, to some extent justly, preferred against English beer, are in the main attributable to the vicious system of dilution, my charge that the addition of gin and other alcoholics is, at all events, intelligible. I said that I should no longer put down in the certificate that the beer was of the nature, substance, and quality demanded, for I did not know what the public demanded. Licorice and sugar are often found in beers, and a very mawkish drink they make, in the absence of pleasant bitters, and with very little alcohol.

Mr. Salamon goes on to say that neither Mr. Young nor I assert that the ingredients are absolutely noxious, but, immediately after a quotation from the *Nineteenth Century*, he adds: "If, however, noxious substitutes have been brought under the knowledge of Dr. Bernays, his position as public analyst demands that he should have reported them to Somerset-house. As a result of the inquiry, I find that he has not done so. He was, it is true, in the year 1878, concerned in a prosecution which charged a publican, who bought his beer from Messrs. Meux and Co., with having added salt thereto. But the prosecution broke down and was withdrawn; and since that time Dr. Bernays has been content with the expression of his opinion upon the subject, and it must be admitted that his views are totally at

variance with those of specialists who have devoted years of study to the question."

I venture to say that this is a very incorrect representation of the case. As regards reporting to Somerset-house, the Act requires nothing of the kind, so I need not further answer that charge. But, in the prosecution alluded to, I had stated that I had found 92 grains of chloride of sodium in the gallon. Only one beer was brought into court, but there were others of the same brewers.

As to the accuracy of the quantity of chlorine found, these are the results of the analysis of one sample made by five of us at the Laboratory of St. Thomas's Hospital in 1878.

Grains of Chloride Reckoned as Chloride of Sodium.

	Per gallon.
Bernays	111·1
Stewart	109·9
Clayton	112·7
Ponder	111·5
Phillips	110·6

I have never taken a case into court where the analysis was not confirmed by a duplicate, and having the courage of my convictions, one of the beers became a prosecution.

The brewers employed counsel, and after the first hearing were so struck with the fairness with which the case was presented, that they employed me professionally to make the analysis of their deep-well water as to chlorides, of various saccharines, and of malt and hops. They used no malt substitutes except the permitted saccharum.

I received every attention from the brewers, who seemed to regard the science of the matter as of most importance. The arrangement made between the lawyers I had nothing to do with; but before quoting the conclusion of the matter before the magistrate, I may be permitted to affirm that the counsel for the defendants would not have permitted the withdrawal of the summons if the analyses had been incorrect. It is true that I did not know at the time that the chloride in the sugar was present as chloride of potassium chiefly, but as regards the taste, the chloride of potassium is much more unpleasant than chloride of sodium. "Dr. Bernays said that he was perfectly satisfied that neither Messrs. Meux nor Mr. Ayres mixed salt with the beer. The chlorides would exceed sixty grains per gallon by the evaporation of the water used at the brewery, and from the sugar twenty grains, making eighty grains. There would be a little salt from the malt and hops. He did not think any salt was added, but he thought that if less sugar, and of a better quality, was used, there would be less salt. Mr. Hunter, solicitor for defendants, assured his worship that for the future Messrs. Meux and Company would use less sugar and of a better quality, and they would use such means as to reduce the chloride of sodium in the water. Dr. Bernays repeated that there was not the slightest suspicion that salt had been added. The magistrate told Mr. Simpson, Clerk of the District Board, that if such was the case, and under all the circumstances, he had better withdraw the summons."

I assert that this case does not bear the gloss which Mr. Salamon has chosen to put upon it, and that it was my duty as public analyst to bring it into court. Messrs. Meux have honourably kept to their promise, as I have since found by again and again analysing their brews.

Since this case I have only had two prosecutions of publicans for adding salt to beer. In the one case the brewers assisted me, and we won; in the other the publican bolted.

With reference to waters, having had much to do with the analyses of deep well waters in London, I say some of them are more than doubtful, from the large amount of chlorides, sulphates, nitrates, and carbonates of sodium, potassium, calcium, and magnesium, and I do not consider them fitted for brewing purposes. They are almost medicinal in their action.

As to my statements, as referred to by Mr Salamon, with reference to more injurious alcohols being produced from various malt substitutes, I adhere to them.

In conclusion, I have no hesitation about thanking him for much that he has stated in his able paper. Although I have had most to do with impure beers I have been often employed professionally as to the manufacture of genuine beers made from malt and hops, and I am not speaking without knowledge.

ALBERT J. BERNAYS.

St. Thomas's Hospital,
Medical and Surgical School,
Feb. 16th, 1887.

THE ELEMENTARY EDUCATION QUESTION.

I regret that the weather and the state of my health prevented my attendance at the reading of Mr. Cunynghame's paper on "The Uses, Objects, and Methods of Technical Education in Elementary Schools;" or as to the objects, assuming them to be of making them good, moral, and efficient artisans, earning high wages, I might have stated the extending uses displayed in the manual training on the half-time principle, as was contended for by Sir Henry Cole and other members of the Council with me, and its progress, which many of our members will be pleased to hear. I might have done this, as I would do now, by submitting to attention, a statement of it, as one of the alternative remedies which I propose as affecting the future character and condition of the population of Ireland. I submit that the public educational functions, instead of being set aside as a detail of no material account, and being relegated by party politicians to inferior hands, ought

to be pressed for consideration as of the highest order of importance in its bearing on the early future of the people and of the realm. The result of the elementary education, such as it is, gives three and four times more of illiterates on the electoral lists of large districts in Ireland than in England. In the United States the illiterates are found to be elements of disorder and corruption, so that in those States the chief special agitation operates for their disfranchisement. The conclusion there is that sound education is requisite for the safe exercise of the local and general franchise. The common teaching service for Ireland is weaker than in Scotland or England by upwards of one-third as to salaries, with inferior residences commonly in bad sanitary conditions, which led the best trained teachers to leave that service for the better pay of commercial service. An Imperial policy would apply, instead of the least, the greatest power of teaching and training to the worst educated and the most depressed districts. The power of physical training, of exercises developing the mental qualities implied in the term discipline, patience, self-restraint, restraint of passionate impulse, and prompt obedience to command and order will be found displayed by Irish children in the Royal Military Asylum at Dublin. I have not the last return, but I give the following, a former return of the outcome of the School at Dublin, which continues, I believe, to yield much the same results of physical and mental training on the half-time principle upon former waifs and strays, as vagrants and mendicants in the streets :—

Rank Obtained.	
Commissioned Officers	6
Staff Sergeaats	2
Colour Sergeants	5
Band Masters	2
Sergeants	35
Drum and Trumpet Majors	10
Corporals and Bombardiers	42
Drummers	164
Privates	255
Total	521

Character.	
Exemplary	28
Very good	149
Good	304
Indifferent	31
Bad	12
Very bad	0
	524

Very similar outcomes are displayed in the district pauper half-time schools, and in district schools in England and in Scotland, thereby imparting to two the efficiency and value of three in aptitude for civil occupations of the former waifs and strays, hereditary mendicants, and delinquents; and thus is produced a large proportion of foremen and mechanics with aptitudes for the increasing demands of service in conducting and supervising machinery. Such results as those cited are the more remarkable, as a large proportion of the pupils are advanced in age and in hardened habits when taken in.

Sir Philip Magnus, in an article on manual training in school education in the *Contemporary Review* for October, quotes Mr. Swire Smith, a member of the late Commission on Technical Instruction, who states "that the half-time children of the town of Keighley, numbering from 1,500 to 2,000, although they receive less than fourteen hours of instruction per week, and are required to attend the factory for twenty-eight hours in addition; yet obtain at the examinations a higher per-centage of passes than the average of children throughout the whole country receiving double the amount of schooling." Similar experiences may be cited from Ireland. In the district schools, where they receive orphans who have been trained in the Board schools, they always find their mental training below that of the half-time children. Sir Philip presents the experience as new—as it doubtless is to him—but he might have found that the like experiences had been developed at the Central District School of the City of London itself a quarter of a century ago, and was displayed in evidence before the Commission of Elementary Education in 1861, and in repeated demonstrations that the long-time system is in violation of the laws of physiology, and that in the omission of physical training. The recently awakened attention to the subject may, however, be welcomed.

This system was introduced by myself and my colleagues under our Commission of 1833 on the Employment of Young Persons in Factories, to prevent over-work, and also to prevent under-education, by requiring three hours attendance in school. It was devised chiefly for the protection of children against over bodily work, also to serve for protection against over, as well as under, mental work, in which it has been—when properly administered—eminently successful, as well as in maintaining juvenile earnings. It is now made the basis of the education in the Army and Navy schools, and in District Poor-law schools, and industrial and reformatory schools, comprising upwards of fifty thousand schools in which there is physical training. It is in the course of extension in France and in Germany. In his recent report on the elementary education on the Continent, Mr. Matthew Arnold states that "there are now 2,989 half-day schools in Prussia in which all the children have but half a day's schooling." "It is found that the rural population greatly preferred the half-day school—as it is called—for all the children, because they had thus the elder children at their disposal for half the day," *i.e.*, for remunerative employments. But Mr. Arnold appears not to have been informed that, notwithstanding the excellence of the long-time elementary teaching there, it fails to reduce the amount of crime,

which is much greater in Germany and Berlin than in this country—and the same fails also here; but that the physical and industrial training here, which augments the capability of the immediate earning of good wages, reduces crime everywhere effectively, and is the only system of elementary training of which I have heard that does so. An arrangement may be made for that method of teaching for the Roman Catholic children of Ireland, as they have in England. The results obtained in the reformatory and industrial schools in Ireland, as reported by the late Sir John Lentaigne, are in satisfactory analogy with those obtained in some institutions in England. The educational change required may be desired solely on the grounds of the economy of the work. In the organisation of schools on a large scale, there is a gain of educational power from better classification for some simultaneous class teaching, with a better paid and more highly qualified staff, and more speedy results at a lower cost. In the average small school of 100, with a master and mistress at £100 per annum, the instruction can only be given at an annual cost of £1 10s. per head, or at a total cost for six years of £9 per head; whilst in the larger school of 700, with a staff of teachers and a female teacher at £240, the cost of the teaching power is reduced to £1 per head, and the work is accomplished in from three to four years at a total cost of £4 per head. In the large half-time schools the same buildings, with the same staff, may be made to accommodate double sets of half-timers on the same day. In the larger district schools the cost of the physical and industrial training, as well as the mental training power, is from £1 5s. to £1 10s. per head of the pupils, as against £2 5s. per head of the common long-time Board schools. It is the opinion of the most experienced of the teachers in these schools that the half-time principle must become generally prevalent. The late Sir John Lentaigne, in his report for 1842, declares that the statistics for those of Ireland "show how completely the character of a nation can be changed by judicious legislation applied to the proper training and treatment of the young." This independent opinion is in accordance with my conclusions enunciated some years ago from the independent experience of England of the power of mixed physical and mental training for early chan ging the characte of a nation.

School teachers of the widest experience in the training in order and discipline on this special half-time system declare that of "pure orphans" of Irish parents, whom they have had to train from the earliest infancy on the half-time principle, that it goes far to remove racial differences, and that when they get "pure orphans," that is infants taken immediately from the mother's breast, they do not observe any difference between their outcome and that of other orphan children in their institutions.

In the "Memoirs" of Lord Shaftesbury, vol. ii. p. 129, it is stated that two days before he left the House of Commons in 1846, he read the remarks of the Committee of Operative Spinners, who had hitherto been extremely opposed to the clause which limited the labour of children to half time, but having made inquiries all over the country, found that by the measure which reduced the working time to six hours in the day, with enactments for education, their physical and moral condition had been improved to such an extent *that they do not appear to be the same race of beings*. The perception on the part of that class is valuable, but it is common with others that the system does actually effect a social change, and this is only now beginning to be perceived. But it was due to have mentioned, and it probably was mentioned, that the provision was beyond the scope of the movers of the Ten Hours Bill, and was the work of my colleagues of the Commission of Factory Inquiry, together with sanitary provisions and securities for the execution of the law, and for the due protection of the workpeople by skilled agents acting under central direction. This was, indeed, the first new "centralisation for the people," and which was afterwards extended to the mining and other branches of labour.

EDWIN CHADWICK.

East Sheen, Feb. 21, 1887.

MUSICAL PITCH.

When through the exertions of the late Commandant of Kneller-hall, General Whitmore, uniformity was secured throughout our military bands, it was felt that it would be inappropriate to occasion, without paramount cause, a renewed disturbance of the musical instrument trade; and though the inconvenience of having our orchestras frequently varying, and generally screwed up to nearly half a tone above that intended for the voice by continental composers, was keenly felt, it was deemed expedient not to adopt the normal diapason or French pitch, till its adoption had become more universal. This was effected by the accession of Italy, and more particularly of Austria and Germany, so that the normal standard may be considered the universal pitch of continental Europe. The Council of the Society of Arts fully recognised the importance of this event, and withdrew its own previously established pitch, in order to facilitate the adoption of a definitive standard.

The ready appreciation of the altered circumstances by our military authorities has been evidenced by their requesting a report from Col. Thompson, the present Commandant of Kneller-hall. It had been supposed that an alteration of pitch would be difficult and unsatisfactory with brass instruments, and impossible with wood instruments, so that the adoption of the French pitch would have involved an utter sacrifice of instruments now in use. Now it has been proved that brass instruments can be easily

altered, and those of wood quite as satisfactorily, though not so easily. In fact, the Belgian firm of Mahillon and Co. have actually accomplished an analogous adaptation of the military instruments of that country with perfect success. To test this, Col. Thompson entrusted to them for alteration to the normal diapason, a Kneller-hall clarinet and bassoon, and their change has been effected for a reasonable amount, expeditiously, and with a thoroughly satisfactory result; they being now as perfectly in tune in the normal diapason as they were previously in the English, or "Kneller-hall" pitch.

It will be seen by the appended table of charges supplied by Messrs. Mahillon, that an ordinary set of band instruments might be altered by them for about £35, and there is no reason to doubt that our English instrument makers could, if put to the test, prove themselves perfectly competent to sustain an honourable competition. According to calculations made by Col. Thompson, the sum required for our regimental bands would be about £7,000, to which about £2,000 should be added for the flutes and bugles of the infantry, and the trumpets of the cavalry of our regular army.

The change of the military pitch would unquestionably become a national change, and it is not merely from a military point of view, but, as a matter of national importance, that must be considered the pecuniary provision to be made, which ought not to be allowed to fall on the officers who maintain the bands in the British army. The most satisfactory solution would be, that the Society of Arts, which has already taken so leading a position in this matter, should, in pursuance of a new vote recorded by a representative gathering of persons eminent for their knowledge of and interest in musical progress, petition Parliament to grant the necessary supplies. Thus might be secured to this country what may henceforward be styled "The Universal Musical Pitch," a token of enlightened progress of which it is stated that her Majesty has already testified her appreciation by ordering its adoption in the Royal private band.

T. TWINING.

Twickenham,
February 7th, 1887.

APPENDIX.

The following are Messrs. Mahillon's charges for the alteration of band instruments from the English to the French pitch:—

Wood.	
Clarinets, B♭ or E♭	15s. each.
,, tenor or bass	18s. ,,
Flutes or Piccolos	8s. ,,
Oboes	15s. ,,
Bassoons	30s. ,,
Brass.	
Cornets or Trumpets	14s. ,,
French Horns	20s. ,,
Sax or Melody Horns	14s. ,,
Saxophones or Sarrusophones	28s. each.
Althorn or Baritone	14s. ,,
Trombones, tenor or bass, slide or valve	14s. ,,
Euphoniums or Bombardons, 3 valves	14s. ,,
Euphoniums or Bombardons, 4 valves	16s. ,,
Field Trumpets, or Field Bugles	4s. 6d. ,,
Flutes or Piccolos as used in the corps of drums and flutes	8s. ,,

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 2.—"The Cultivation of Tobacco in England." By E. J. BEALE. SIR EDWARD BIRKBECK, Bart., M.P., will preside.

MARCH 9.—"Railway Brakes." By WILLIAM P. MARSHALL. Sir FREDERICK BRAMWELL, F.R.S., will preside.

MARCH 16.—"Machinery and Appliances used on the Stage." By PERCY FITZGERALD. SIR FREDERICK POLLOCK, BART., will preside.

MARCH 23.—"The Living Organisms of the Air; the Effect of Place and Climate on their Prevalence." By Dr. PERCY FRANKLAND. PROF. BURDON SANDERSON, M.D., F.R.S., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MARCH 4.—"Traffic Routes to the East." By MAJOR-GENERAL SIR F. J. GOLDSMID, K.C.S.I., C.B. SIR JULAND DANVERS, K.C.S.I., will preside.

MARCH 25.—"Indian Coffee." By FREDERICK CLIFFORD.

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

MAY 27.—"Indian Tea." By Dr. T. BERRY WHITE. H. S. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 1.—"The Colonial and Indian Exhibition." By EDWARD CUNLIFFE-OWEN, C.M.G.

MARCH 29.—"Colonial Wines." By RICHARD BANNISTER.

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

MAY 17.—

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 15.—"The Application of Gems to the Art of the Goldsmith." By ALFRED PHILLIPS. SIR GEORGE BIRDWOOD, M.D., LL.D., C.S.I., will preside.

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

CANTOR LECTURES.

The Third Course will be on "Building Materials." By W. Y. DENT, F.C.S., F.I.C. Four Lectures.

LECTURE III.—FEBRUARY 28.—Lime.—Kilns used in the calcination of limestone.—Mortar.—Cements.—Manufacture of Portland cement.—Utilisation of blast-furnace slag.—Plaster of Paris.

LECTURE IV.—MARCH 7.—Asphalt described.—Timber: causes which promote its decay.—Methods adopted for its preservation.—Description of the creosoting process.—Painting.

The Fourth Course will be on "Testing Materials of Construction, especially Iron and Steel." By Prof. W. C. UNWIN, F.R.S Three Lectures.

March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Chemical Changes of Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Y. Dent, "Building Materials." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. T. Rigby, "Dairy Education."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. Delmar Morgan, "Prejevalsky's Journeys and Discoveries in Asia."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. Conder, "Domestic, Civil, and Palatial Buildings in Japan."

Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. A Fyffe, "Poland, or the Disappearance of the Unfittest."

TUESDAY, MARCH 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Edward Cunliffe-Owen, "The Colonial and Indian Exhibition."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture VII.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m. Annual Meeting.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. John James Webster, "Dredging Operations and Appliances."

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. E. B. Poulton, "The Experimental Proof of the Protective Value of Colour and Markings in Insects (and especially in Lepidopterous Larvæ) in their Relation with Vertebrata." 2. Mr. G. A. Boulenger, "An Account of the Fishes collected by Mr. C. Buckley in Eastern Ecuador." 3. Mr. Richard S. Wray, "Note on a Vestigial Structure in the Adult Ostrich, representing the Distal Phalanges of Digit III."

WEDNESDAY, MARCH 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. J. Beale, "The Cultivation of Tobacco in England."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. B. Haughton, "Wave Percussion."

THURSDAY, MARCH 3...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Alfred W. Bennett, "Genetic Affinities and Classification of Algæ." 2. Messrs. George Massee and D. Morris, "Fungoid Disease of Colocasia in Jamaica."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. Rennie, "The Colouring Matter of Drosera Whittakeri." 2. Messrs. F. R. Japp and C. F. Burton, "Anhydracetonebenzil," and "Condensation of Benzil with Ketones." 3. Messrs. F. R. Japp and E. Clemenshaw, "The Constitution of Glycosine." 4. Mr. F. R. Japp, "Diphenylglyoxaline and its homologues." 5. Dr. W. H. Perkin, jun., "Dehydracetic Acid."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. J. Radcliffe, "Musical Instruments."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Alfred Gilbert, "Some Peculiarities of Musical Organisation."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Edmund Gosse, "The Critics of the Age of Anne." (Lecture II.)

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, MARCH 4...SOCIETY OF ARTS, John-street, W.C., 8 p.m. (Indian Section.) Major-General Sir F. J. Goldsmid, "Traffic Routes to the East."

United Service Institute, Whitehall-yard, 3 p.m. Mr. R. G. Haliburton, "A Supply of Cavalry Horses, and the establishment of a Cavalry Depôt in Japan."

Royal Institution, Albemarle-street, W., 8 p.m. (Weekly Meeting, 9 p.m.) Mr. V. Horsley, "Brain Surgery in the Stone Ages."

Civil Engineers, 25, Great George-street, S.W., 7 p.m. (Students' Meeting.) Mr. Sidney H. Wells, "Propelling-Machinery of Modern War-Ships."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Prof. Windisch, "The Inscription of Gortyn."

SATURDAY, MARCH 5...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Sound." (Lecture II.)

Journal of the Society of Arts.

No. 1,789. Vol. XXXV.

FRIDAY, MARCH 4, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list of subscriptions by members of the Society of Arts to the funds for the Imperial Institute since the list published in the last number of the *Journal*:—

	£	s.	d.
Sir Frederick Bramwell, D.C.L., F.R.S., Vice-President	100	0	0
Admiral Hon. Arthur A. Cochrane, C.B.*	10	0	0
W. E. Garstin	2	2	0
James Holdsworth	1	1	0
Major E. W. Mathew, J.P., D.L.	1	0	0
Edward Mucklow, J.P.	2	0	0
Henry Sandford	1	1	0
Sir Francis Villeneuve Smith	10	0	0
Major-Gen. Richard Hugh Stotherd, C.B.	2	2	0
Stephen S. Tayler	2	2	0
Amounts previously acknowledged	1,841	9	0
Total	£1,972	17	0

CANTOR LECTURES.

Mr. W. Y. Dent, F.C.S., F.I.C., delivered the third lecture of his course on "Building Materials," on Monday evening, 28th inst., in which he dealt chiefly with mortar and cements, more particularly with Portland cement.

In consequence of ill-health, Dr. Fredk. H. Bowman will be unable to deliver his course of Cantor Lectures on "The Structure of Textile Fibres," announced for April 25 and four following Mondays. Mr. J. M. Thomson, Sec.C.S., will therefore deliver the concluding course, which will be on "The Chemical Changes of Putrefaction and Antisepsis," and will be given on Mondays, May 2nd, 9th, 16th, and 23rd.

* Admiral Cochrane was present at Her Majesty's Coronation in Westminster Abbey, in 1837.

Proceedings of the Society.

INDIAN SECTION.

Friday, February 25, 1887; J. M. Maclean, M.P., in the chair.

The paper read was—

NEW MARKETS AND EXTENSION OF RAILWAYS IN INDIA AND BURMAH.

By Holt S. Hallett, F.R.G.S.

You are all aware that the Commission on Depression of Trade, after carefully weighing the evidence that was laid before it, came to the conclusion that our trade, together with that of our foreign rivals, was suffering from over-production and its natural effects; excessive competition, and the nearly total absence of profits. The only panacea for this over-production, outside diminishing supplies, is to acquire fresh customers by opening out new markets.

You will therefore, I am sure, listen attentively to me this evening, whilst I am bringing to your notice the vast unopened markets which are within our reach in India and Burmah, and point out how easily and remuneratively these might be opened to our commerce. Unless we open these markets, and carry our trade into them, and into the vast unopened markets of China and Indo-China, many of our manufactories, in presence of the ever-growing protective tariffs of our rivals, must be closed, and our workmen turned into the streets to find their living elsewhere in the world. The only choice we have remaining to us is to acquire new customers, or to arrange for an enormous scheme of emigration, thus losing a valuable portion of our population.

Great changes have been occurring in the world of late years, without our, until very recently, taking an intelligent interest in their probable results.

In Great Britain, fifty years ago, two-thirds of the working-class were employed upon agriculture. Now, only one-fourth are so employed. One-half of the population of Great Britain is now dependent upon manufacturing and distributing pursuits.

We have no room for more agriculturists; many of these have already been ousted from the land by the development of agricultural machinery.

We are losing every year large numbers by emigration, nevertheless our population is increasing at the rate of 300,000 a year. The question is how are we to find means for their support? We cannot do so without increasing the turn-out of our manufactured goods, and the number of our customers.

Looking at the Continent and America, we find the same increase of non-agricultural population, which, together with political causes, has given rise to a vast development of manufactures in foreign countries.

Continental manufactures have been fostered by protective and now nearly prohibitive tariffs, which have forced down the prices in our home markets to such an extent as to cause many of our manufacturers, in order to compete on the Continent, either to move their mills there, or to work their mills here at a considerable sacrifice, not only of profits, but of formerly earned savings.

We are fast being excluded from our old markets. As we lower our prices the foreign tariffs are raised, and will doubtless continue to be raised until our wares are generally shut out from Continental markets. Even now foreign manufactories have so developed that their home markets no longer suffice. Foreigners have become our rivals, and are seeking—and in many cases successfully seeking—abroad and in our colonies for extension of their trade. The opening of the Suez Canal, together with the institution of direct steam carriage from foreign ports to places formerly chiefly tapped by this country, together with the opening up of mines, cheapened inland water and land carriage, and lower wages, render them formidable competitors in the neutral markets of the world.

Between 1877 and 1883, Austria, Russia, Germany, France, Italy, and Spain, put very heavy duties upon imports, and at the beginning of last year Switzerland, till then one of the advocates of free trade, doubled hers.

The close of the rebellion of the Southern States in America was the commencement of an era of heavy tariffs in the United States. These were imposed partly for fiscal reasons, and partly—and in latter years it may be said chiefly—for the encouragement of home manufactures. The American tariffs are now so high that, according to Mr. Kennedy, the head of the Commercial Department of the Foreign Office, "it would be morally impossible for America to develop her import duties any further in the case of many articles." At present they vary between 50 and 265 per cent. upon articles of import.

Would it not have been better for the extension of our commerce, if the £400,000,000 that we have invested in United States railways, had been invested in those of India. America either shuts the door in our faces when we ask for her custom, or, if she cannot do without our goods, grudges us every half-penny she spends. India is a willing customer. If we enrich her by spending money on her railways, and by opening the world to her produce, she will repay us by taking ever increasing quantities of our manufactures, and will certainly prove an inexhaustible mine of wealth to this country.

The competition of the world is becoming keener and keener every day. Cheap carriage has annihilated the effects of distance, and America, as can be seen from the United States' Consular Reports, has at length awakened to the fact that India can produce as good wheat and cotton as herself, and that it will be madness to attempt to compete with the six-cent native of India, when, with increased railway communication, he can supply the markets of the world.

Increased facilities of communication, whether by water or by land, increase the volume of our trade. By them the circle of possible purchasers is increased—purchasers who had been kept from buying our goods, owing to the expense of transit enhancing prices to such an extent as to prevent machine-made goods from competing with local hand-made manufactures—purchasers who would be benefited and enriched by the world being opened as a market for their own local productions.

Consider what steamers and railways have already done for the revenues, trade, protection, enrichment, and advancement of the people of India.

With increased trade facilities, and a falling exchange, the exports of India have been increasing marvellously—since 1879 wheat has leapt from 2,000,000 to 56,000,000 bushels; the exports from the United States falling from 122,000,000 to less than 75,000,0000 bushels. The figures are not less significant regarding other exports. The great increase in its foreign trade during the last ten years is surprising. While that of England has declined 0·6 per cent.; and France increased 7·27 per cent., Germany 7·89 per cent., and the United States 21·4 per cent., India has increased 57·49 per cent. In 1885-6, the im-

ports were 67,28,93,813 rupees in value, and the exports 84,91,56,777 rupees.

If you take a map of India and Burmah, with the present existing railways marked on it, and cut out a map of England and Wales, drawn to the same scale, you will be astonished to find how many places in India and Burmah you can place that map of England upon without covering a single mile of railway. Take, for instance, the portions of the country lying to the south-west and east of Calcutta; there you may, on either side, place in a lump the whole area of the United Kingdom without touching a mile of railway. Railways in India are in their infancy. If India were as as well supplied with railways as England is, it would have 365,000 miles, instead of the paltry 12,376 miles it now has. If the Indian Government continues the construction of railways at the same rate that it has been doing during the last thirty years, it will take more than 900 years to give it, for its area, the equivalent mileage of England.

When we consider that the area of India is thirty times that of England, we cannot help thinking that Sir John Gorst is laughing in our faces as he flouts bravely before us the intention of Government to construct 1,167 miles this year in our huge empire of India. Such an amount is equivalent to the construction of thirty-nine miles in England.

Look at the excuse that the Indian Government gives for doing nothing, and allowing the rupee to diminish to 1s. 6d. in value. The only excuse they have is the fear of further loss by exchange.

See what a bugbear this silver question of exchange really is, and how every soul that has dealt with it has been befooled by it. All have been too much taken up with their pet doctrinaire notions to take a common sense and broad view of the subject—to take hold of the sham bogie and look at it all round. The solution of the silver question lies in a nutshell, but they have failed to crack the nut; when it is cracked, the answer is very simple, so simple that all will wonder that they never thought of it before.

The fact is, only a limited amount of silver can be got out of the earth each year, which, unless required for coinage or other purposes, decreases in value, and becomes a drug upon the market. If a pennyworth of silver is required more than the market can supply, up goes the value of silver; if a pennyworth less, down it goes again. At present, or rather for the past few years, from extraordinary circumstances, large quantities have been thrown upon the market, which have been nearly entirely, but not quite, absorbed by India, China, and other silver coinage countries of the world. Things might have been righted any time by bold action on the part of the Government of India, but timorous over-caution has palsied its hands, and removed all power from its mind of correctly estimating the probable effects of courageous action in the matter of exchange.

If the Government of India, instead of trembling with fear lest the Bland Bill for the coinage of £5,000,000 worth of silver should be repealed, had determined to expend the £4,000,000 a year it is at present losing by exchange, as interest on borrowed or on guaranteed capital for the construction of the much-needed railways for our Indian Empire, there would be no surplus silver in the world, and the rupee would again rise to its old value of two shillings.

In the Third Report on Depression of Trade the estimated stock of silver in money, and hoarded, in all civilised countries, at the end of 1884, has been valued at £437,550,000.

Of the sums expended on Indian railways, one-fourth is spent on railway materials in England, and three-fourths for construction purposes in India. The amount expended in India is of course in silver. Now supposing that it was intended to spend £400,000,000 during the next ten years upon Indian railways, £300,000,000 of this expenditure would be in silver, such an expenditure would not only swallow up for ten years the whole of the £25,000,000 yearly mined in the world, outside China, but would deplete the hoardings and coinage of the civilised world by £50,000,000, or by £5,000,000 more than the total present coinage under the Bland Bill.

But from this amount the interest payable by the Government of India would have to be deducted; but this would certainly be far more than balanced by the payments in silver for the greatly increased exports of wheat and cotton, which would certainly occur during the construction of these railways.

If we take the cost of a mile of Indian railway at £6,000 when the rupee is valued at 2s., and remember that three-fourths of the expenditure will be in silver in India, we find that whilst an expenditure of £400,000,000 when the rupee is at that value would enable 66,667 miles of railway to be constructed, an expenditure of the same amount when the rupee is at 1s. 6d.

would cover the expenditure upon 79,166 miles of line.

Again, if only 66,667 miles were required, this mileage could be constructed for £325,000,000 when the rupee is at 1s. 6d., whilst £400,000,000 would be required if the rupee was at 2s.

It is, therefore, evident that the construction of railways in India, when the value of the rupee is low, is a distinct and decided advantage to the Government of India.

The saving of £75,000,000, the difference between £400,000,000 and £325,000,000, would thrice cover the net loss accruing to Government during the ten years the railways were being constructed by the Government.

As to the increased liabilities that would be incurred by Government carrying out so extensive a scheme for railways, I would point out that a railway constructed in the first year would, in ordinary course, pay 1 per cent. in the third year; 2 per cent. in the fourth year; and, taking the average of Indian railways, 5·8 per cent. in the eighth year; the gross amount of interest or guarantee would, therefore, not be required in any one year.

Take, for instance, £400,000,000 borrowed and expended by Government in sums of £40,000,000 a year, at 3½ per cent. per annum, the total net interest payable would be only £31,080,000, or an average of £3,108,000 for each of the ten years the railways were under construction. This is about a million less than is lost each year by the Government losing £4,000,000 by exchange operations. In the subsequent ten years the gain to the Government would be £70,980,000 over and above the interest payable in that time, or about £40,000,000 more than they had paid for interest during construction. (See statement A., p. 364.)

If half of the railways were made by Government and the other half by guaranteed companies, on a 3½ per cent. guarantee, with the proviso that Government should share in any profits over 5 per cent., the loss to Government in the first twelve years would be £34,400,000, or £2,866,666 a-year. Still the average loss during construction would be less than the present loss by exchange, the money spent in construction would add to the wealth of the people of India, and the silver markets would be so depleted, that the rupee would certainly go up above par, unless a gold coinage was allowed for India. This question of a gold coinage for India is of the vastest importance to our home commerce; our merchants are now receiving only 1s. 6d. for what they might be getting 2s. for, if the rupee was at its natural value. The net gain at the end of the following eight years, after deducting the lump sum of the interest that had been paid, would be £3,750,000 (see Statements A and B, pp. 364 and 365). If the net earnings of the companies over 4 per cent. were divided, and half taken by the Government, the net gain would be increased to £13,250,000, and the net gain in every succeeding year would be £6,400,000 In the interest of the rapid construction of railways, and the absolute necessity of opening up the country as quickly as possible for the extension of our commerce, I consider that the joint action of Government and guaranteed companies is to be preferred.

If such a policy were carried out in its integrity, the present depression of trade, as far as concerns the British Empire, would vanish, the revenues of India would enormously expand, India would prove a mine of wealth to its people, and would easily swallow up all the silver yearly mined in the world. The natives of India would then, indeed, have reason to boast of being British subjects, and of the benefits they derive from being part and parcel of the British Empire. The silver question is a phantom brought in being by the foolish faint-heartedness of the Government of India.

To show you how favourably the investment of capital in railways in India compares with investments in other countries, I may state that, in 1884, the per-centage paid upon the railways in the chief countries in the world were as follows:—

			Per cent.
United States railways paid, 1884		..	4·4
England	,, ,,	..	4·2
Germany	,, ,,	..	4·2
France	,, ,,	..	4·1
Australia	,, ,,	..	3·9
Spain	,, ,,	..	3·8
Scotland	,, ,,	..	3·7
Ireland	,, ,,	..	3·6
Belgium	,, ,,	..	3·5
New Zealand	,, ,,	..	3·1
Italy	,, ,,	..	2·5
Portugal	,, ,,	..	2·5
Russia	,, ,,	..	2·2
Denmark	,, ,,	..	2·1
Canada	,, ,,	..	1·8
India	,, ,,	..	5·3
India	,, ,, 1885	..	5·8
Or, taking the rupee at 1s. 6d.		..	4·3

Thus, even with the loss of exchange, the Indian railways—half of which were not in existence

in 1874, and one-fourth not in 1880, and many of which are yet far from completed—are already paying only 0·1 per cent. less interest than those of the United States, which have earned the highest average dividend in the world.

When it is considered that most of the Indian railways are utterly destitute of branch feeder lines, which when constructed must greatly tend to develop their traffic, there can be no doubt that the paying prospects of the Indian railways are far better than those of any other country in the world.

I will now turn for a time to the necessity of developing the railway system in India, both on account of the natives of that country, and the manufacturers, merchants, and workmen of Great Britain.

The importance of India to the commerce of Lancashire and other parts of England, was laid stress upon by the witnesses at the late Commission on Depression of Trade. Mr. Stuttard, one of the largest cotton-spinners, declared that India was the most promising market for British trade. He said that "India is the best of all, on India we rely, and if we lose India, Lancashire is practically ruined." The value of the total export of cotton goods and yarns in 1884 was £65,000,000. Of that India took £20,000,000; China, £6,000,000; India, China, and the Straits Settlements together took nearly one-half of our total export. Last year India took £20,952,000 worth out of our total export of £61,659,000; whilst the United States only took £1,149,000 worth.

In his speech at Ashton-under-Lyne, on the 11th of last month (January, 1887), Viscount Cross, the Secretary of State for India, remarked that "if it had not been for the railways in India, there was no doubt the Government revenue would have been in a very awkward condition;" and I think you will agree with me that if it had not been for the railways in India, both our cotton, and iron, and steel industries would have been depressed to a much greater degree than they were.

Knowing how useful railways have proved in times of war, famine, and insurrection: knowing that only one-half of the cultivable land in India is taken up; that out of a population of 268,000,000 only 74,000,000 can now gain their living from agriculture: that all available land is seized upon as fast as the railways open it up; and that Government, being the landlord, derives most benefit from increased cultivation: knowing how the people in the absence of railways, will not grow more than their local markets require, that surplus grain lies rotting on the ground whilst famine is raging a few hundred miles away: knowing that the population is huddled together in dense masses, simply because the country is not sufficiently opened up to enable them to migrate cheaply to waste lands requiring population; and that famine must come some day to this ever-increasing dense population, unless migration occurs in time to avoid it: knowing that the earnings of the people, the so-called poor natives of India, are doubled wherever railways proceed; that most of the world-famed mechanics of India have only local markets for their works of art; that the increase of railways would lead to the spread of manufactories, and the more lucrative employment of millions of the people, as well as to the further destruction of the bonds in which caste has bound this industrious people, and would greatly tend to raise them in the scale of civilisation: knowing that railways would greatly cheapen the price of salt and other articles of consumption to the people, as well as enormously develop the sale of European manufactures and machinery, and thus tend greatly to the welfare of our fellow subjects at home and abroad: knowing all this, which was fully brought before the House of Commons Committee which sat in 1884 on East Indian railways, is it not pitiful that the Secretary of State and the Government of India can complacently look on and refuse to expedite the construction of railways by such concessions as would enable them to be placed upon the stock markets of the world.

Surely it is time for us, deeply concerned as we are in the welfare of India and the extension of our commerce, to interest ourselves in our Eastern affairs, to investigate them and observe how General Strachey, the Public Works adviser of the Secretary of State, has continuously stifled the expenditure of private capital in India by persuading every Secretary of State who comes into office to wait and wait through weary years whilst the poor native of India is lingering in poverty, and our commerce is famishing for extension of markets, for the chance that possibly the British public may be persuaded, at some future time, to construct the railways of India upon harder terms than they accept elsewhere in the world.

It is to be hoped that the new Secretary of State for India, Viscount Cross, will resolutely

follow up the words of his speech at Ashton-under-Lyne, where he stated that "he wanted the people of England to come forward and say that they would advance money to help Government to extend the railway system of India. Railways could not be made without money. He hoped to be able to provide powers to make these railways, provided the people would come forward and put their money in them."

The Secretary of State for India is fully aware that Sir Juland Danvers, Secretary for Indian Public Works, expressed the opinion before the Committee that he considered "3½ per cent. ought to be enough to induce capitalists to give their capital towards railways, provided they had the opportunity of increasing that amount by surplus profits."

If such terms were offered to capitalists, there is no doubt that the capital for fifty or sixty thousand miles—the mileage actually required for the immediate development of India—would find subscribers not only in Britain, but on the Continent and in the United States.

Whether it is intended that a guarantee of interest shall be granted by the Secretary of State, or whether syndicates will be enticed to the India-office and offered the Bengal and North-Western terms, of which General Strachey, in his evidence before the East Indian Railway Committee, remarked, "it is quite true that the promoters of that found that they had burnt their fingers," I do not know. Anyhow, it was not very wise, in the interest of India railway construction, for the Secretary of State, or his adviser, General Strachey, to induce Messrs. Baring and Rothschild to burn their fingers upon the first railway they were persuaded to take up in India. The greedy hand does not always get the largest handful, and the stoppage for several years of the flow of all private capital into the Indian Government enterprises is a lesson that may well be laid to heart by General Strachey and the Government of India.

The granting of the three cards, the Southern Mahratta, Central Bengal, and Bengal and North Western terms, by the Committee of 1884, for an irresolute and hairsplitting official to conjure with, whilst syndicates are restlessly waiting, and daily losing chances for turning their money to profitable account elsewhere, if it was not merely the rash proceeding of men taking no account of the consequences which must follow such an action, as inevitably as night succeeds day, must have been intended to practically stop the investment of private capital in Indian railways.

Major Conway-Gordon, in his evidence before the Committee, explained how for years the extension of Indian railways has been delayed by the Council of the Secretary of State refusing to give terms acceptable to the public, when he let out that "the whole history of Indian railways is one long and unsuccessful attempt to get railways constructed without a State guarantee."

Red tape has up till now dwarfed the growth of Indian railways, and this was very clearly stated by Sir Rivers Thomson, the Lieutenant-Governor of Bengal, when he wrote in his Minute of the 26th of July, 1881, that "No one can fail to notice and deplore the difficulties which have arisen from our continued changes in our railway construction policy. From guaranteed railways to partially subsidised private enterprise, from the latter to State railways constructed on borrowed capital, and the intermediate changes which have been rung upon the responsibilities of local governments to pay interest upon the advances made to them, there has scarcely been for five years consecutively any unity of purpose or finality of system." And he goes on to say that "the wonder is not simply that the whole business has not collapsed, but that the Public Works Department is able to show, notwithstanding these fluctuations in the Government policy and its indecision of purpose, the good results which we actually have in the extent and progress of railways in the country."

Let us hope that there will be no further indecision about the rapid extension of our railways in India. The matter is vital to the commerce of this country. Parliament will do nothing in the matter unless the public makes up its mind that this senseless procrastination and indecision shall cease. The Secretary of State will not move unless urged on by the Parliament, and the Government of India will be thankful for rest until urged into action by the Secretary of State. It is for the public to be determined in the matter. It is the old story of "fire, fire, burn stick, stick won't beat dog, dog won't bite pig."

There are at least three courses open to the Government; it can increase its public works establishment and make all the railways itself; it can call in the aid of construction companies, and afterwards decrease its liabilities by leasing the lines; or it can offer such terms to private enterprise as would enable syndicates

to float the railways at par upon the market. It is for the public to resolve that the railways shall be made as soon as possible, and for the Government to carry out the wishes of the public, in a sensible and straightforward manner, to the best of its ability.

One remarkable thing in the history of railway construction in India is that, until within the last year or two, the Government of India considered that it was impossible, or at all events most unlikely, that any railway in India would pay that did not pass through a dense population. For this reason they were for years strongly averse to the construction of railways in Burmah, and these railways would not have been undertaken to this day if the merchants of Burmah had not been ceaseless in clamouring for their construction. Imagine the surprise of the Government when they found that the Burmah railway paid about 5 per cent. as soon as it was opened.

In the same way they denied that there would be a possibility of extensive traffic upon the Rajputana and the Indus Valley railways, which were constructed solely for strategic purposes through a poorly populated country. The narrow gauge was considered more than sufficient for any possible traffic that might come upon these lines; yet, so rapidly was the country brought under cultivation, and the population increased so fast, that in 1885 the Indus Valley railway carried 136 million mile-passengers, and 293 million mile-tons of goods and grain, and paid 7·32 per cent. upon its capital; and the Rajputana line carried 358 million mile-passengers, and 327 million mile-tons of goods and grain, and paid 6·97 per cent. upon its capital. The fact may at length dawn upon the Government of India that railways passing through a new country, where the land has not been thrice cropped for centuries, and where there is room for people to cultivate for export as well as for local use, are certain to be more remunerative than those passing through a dense population, whose agriculture scarcely serves for their sustenance, and where labour competition is so great that the majority of the people are kept nearly on the verge of starvation.

As I have previously stated, hardly one-half of the cultivable area of India is under cultivation. Mr. Hunter, the Director-General of Statistics to the Government of India, in his evidence before the Committee, stated that "We have fairly trustworthy details with regard to about 427,000 miles—that is to say, with regard to rather less than one-half of the whole area of British India. Of these 427,000 miles, 103,000 are cultivable, but not cultivated, against 130,000 which are cultivated at present, the remainder being unclassified or reckoned as uncultivable. We have, therefore, as regards the part of India which we know best, very nearly one quarter of the land cultivable but not cultivated. If you take individual provinces, where one can perceive the real bearing of the question better—for instance, the great Gangetic Valley, which is the most densely populated part of India, you will find around its densely populated tracts three provinces, the Central Provinces, Punjab, and Assam, which have an aggregate of 28,000,000 acres of land cultivable but not cultivated. If you still further confine your view to Assam and the Central Provinces, which stand on both sides of the densest districts, you will find that there are 17,000,000 acres, after all deductions, waiting for cultivation; that is, I believe, an area equal to the whole crop lands of Great Britain, excluding permanent pasture. The ordinary effect of a railway coming into a district is to increase cultivation in two ways: first, by the extension of cultivation, and, secondly, by more intensive husbandry. The Central Provinces had, in 1872, half-a-million tenants-at-will who were called 'new-men,' and who were treated as an insignificant class of the population; during the past ten years those 'new-men,' have increased three-fold. There are now a million-and-a-half of such holdings, and the number of these holdings is equal to the number of all the other holdings put together. This is an example of a railway coming into a province where the land is abundant, and to which people can migrate with advantage."

Mr. Hunter furthermore stated that "there are large tracts that can only be reclaimed by draining; and there are large tracts which would require capital to cut down heavy forests; but there are also enormous tracts which would require very little capital. The Chief Commissioner of Assam describes the cultivable land in his province lying along the bank of the great river Brahmaputra, and he says that you only require a lucifer match to burn the high grass, and a sickle to bring those great tracts of waste land into cultivation."

In the interests of the people of India I cannot do better than impress upon your minds the following answer of General Strachey, when under examination before the Committee of 1884. When asked as to whether the con-

struction of railways in India had increased the value of land so far as to enable the people to more easily contribute the taxes they have to pay, he replied:—"Certainly. The relief to the country is immense. I have estimated in some of the papers that I have written upon the subject, that the saving to the people of India is probably twice the gross income received by the railway companies. It is a very large sum indeed; it amounts to £30,000,000 or £40,000,000, probably, annually. The cost of transport has certainly been reduced one-third."

Since General Strachey gave his evidence, the rates upon some of the Indian railways have been much reduced; take, for instance, the carriage of grain from Delhi to Howrah, a distance of 954 miles, at a rate of 0·27d. a ton per mile, or about eleven times as cheap as it could be conveyed by carts. On one line, passengers are now carried for two-thirds of a farthing a mile, and on many of the other lines they are conveyed the same distance for three-fourths of a farthing. The effect of lowering the rates upon the traffic and traffic receipts has been a marvellous success; for instance, take the four railways in the north of India that lowered their goods rates in 1882; by the end of 1885 their net revenue had increased from 61,240,888 rupees to 71,064,708 rupees, or by one-sixth of the former amount. Then observe the effect upon passenger fares: in 1881, the East Indian railway lowered its passenger rates, by the end of 1885 passengers increased from 7,937,526 to about 19,100,000, or were nearly trebled. These are more instances of the fact that the greedy hand does not hold the largest handful, and these facts show that the revenues of Indian railways have, since their commencement, been seriously crippled through not developing their traffic by means of low and more remunerative rates. Had such rates been charged in the past as are charged at present, the guaranteed railways, notwithstanding the fact that they were constructed at double the cost of the present day, would have earned their full 5 per cent. interest nearly from the first, and would have been a source of vast income to the Indian Government.

The gross receipts on Indian railways increased from £16,066,225 in 1884, to £17,989,625 in 1885, or nearly one-eighth in a single year. With such remarkable results before them, surely nothing should prevent the Government of India from following the example of America, and constructing eight and ten thousand miles a-year, instead of fearfully extending their system by a paltry, indeed, insignificant rate, considering the huge area of the country they have to provide for, of three and four, and five hundred miles in the year, as they have done up till now. The construction of only 12,376 miles in thirty-four years, or an average of not 400 miles a-year, in a country 1,378,044 square miles in extent, a country that is known to require at least 60,000 miles to open it up, is most discreditable to the English nation, which has charge of the destinies of its Indian Empire.

Having shown you how very important it is that a system of fifty or sixty thousand miles of railways should be pushed on as rapidly as possible in India, both for the sakes of the natives of India and the merchants, manufacturers, and working classes of this country, and explained to you why the most unopened parts of India are exactly those in which railways are most required, I will now turn to the railway connection between India and Burmah, which has for some time been proposed and urged upon the public and the Government of India by Mr. Colquhoun and myself.

Mr. Hunter, in the passages which I have quoted, laid stress upon the great richness and sparse population of the Brahmaputra Valley. It is up this valley that we propose to construct a system of railways to connect the sea-ports of Calcutta and Chittagong, with the small line of railway lately made from Debrugarh to Makum. These railways would not only open up the fertile plains alluded to by Mr. Hunter, but would tap the chief tea-producing districts of India, and would be most useful in distributing to other lines the wealth of coal that exists in the hills to the east of the upper portion of the river valley. The lines have already been surveyed by the Government of India, and could be put in hand at once, by the use of either borrowed or guaranteed capital.

The part of the country that they pass through can never be liable to famine from deficient rainfall. The Brahmaputra and the Irrawaddy Valleys form two funnels, up which the heavy water-weighted clouds brought by the south-west monsoon are driven, and the rainfall, at least amongst the high hills skirting the upper portion of the valley, may be said to be nearly perennial. The country at the head of these valleys is the home of the indiarubber plant. It is, unlike the greater part of India, distinctly metalliferous.

At the sources of the Chindwen, or Western branch of the Irrawaddy, are the famous amber and jade mines, which have supplied China with these much-prized stones for centuries. Salt is likewise found in great abundance, and the amber lies in coal beds, which will most likely prove at least as extensive as those at present being mined in the Brahmaputra Valley at Makum.

In the hills between the eastern and the western branches of the Irrawaddy, gold has been mined for centuries, and many people, as can be seen by the report of the Assistant Commissioner, Mr. Matthews, who has lately been placed at Katha, still gain a living by digging for it. Coal likewise crops up in places near the river and is likely to provide an abundant supply for railway and other purposes.

In the hills to the east of the Irrawaddy, and in the Shan plateaux, stretching as far as the sources of the river, there are numerous silver, lead, and copper mines, which have long proved a source of great wealth to the Shan chiefs of the country. It is thus evident that the same mineral wealth which has made the neighbouring Chinese province of Yunnan renowned as the most metalliferous region in the world, stretches from Yunnan westward as far as the valley of Brahmaputra.

You are aware that the Government of India are now extending one of the Burmah lines of railway so as to join Rangoon with Mandalay. To the north of Mandalay stretches a plain some sixty miles long, having an average breadth of ten miles. It is through this plain, and the country to the north of it, that we propose to extend the Burmese railway to the town of Bhamo, which you are all doubtless aware is the entrepôt for the trade of North-Western Yunnan.

Before the outbreak of the late Mohammedan rebellion this trade was valued at £500,000. At that time steamers did not run to Bhamo, and the country was cursed with Burmese misrule. Now that we have brought peace to this long-distracted country, this trade will doubtless again revive, and extend to much vaster proportions. To the east of Bhamo, between it and China proper, lie perched up on high and rich plateaux the Chinese Shan States, which are under the jurisdiction of the Chinese Governor of Yunnan. The requirements of these alone would give a large trade to Bhamo.

Putting Northern Yunnan aside, and not even taking the enormous advantages that neighbouring coal must give to a railway, nor the great effect that such a railway would have in giving our Government a full control of the country, and not considering the large area of culturable land and cultivation through which the line would pass, I maintain that the construction of this railway from Mandalay to Bhamo, and its extension through the Mogoung and Hookong Valleys to join the Indian lines at Makum, is an absolute necessity for the future defence of Burmah against any sudden foreign attack.

At present a foreign fleet might at any time land a force in Burmah, or blockade our seaports, without any possibility of a force being brought to its assistance within a reasonable time, by land, from any part of India. The trade of Burmah is already one-tenth of the trade of India, and has been for years developing by leaps and bounds; there is little reason to doubt, therefore, that in a war with any powerful European State, having a large navy, Burmah, in its present unprotected state, would be one of the places chosen by it for attack. The junction of the Indian railways with Bhamo is likewise absolutely necessary, because the river above Bhamo is unnavigable, even for canoes, during a great part of the year. To the north of Bhamo lies Mogoung, where it is intended to place Mr. Colquhoun as Deputy Commissioner.

Mogoung lies in a valley 15 to 20 miles wide, about 1,000 feet above the level of the sea. To the north-west of Mogoung, separated from it by low spurs of hills jutting out from the Shway-Doung Gyee, and the hills at the head of the Ooroo River, lies the Hookong Valley, which is fifty miles in length, by forty-five miles, feathering off to fifteen in breadth, and elevated 1,100 feet above the sea, or 670 feet above Bhamo, and about the same level as Mogoung. In the hills lying to the north and south of this valley, jade, amber, coal, and salt are mined. Formerly, the valley which forms part of Burmah was populated by Shans, but of late years the Singphos or Kakhyens have driven the Shans out of it.

If properly settled, the hills bordering the Upper Valleys of the Irrawaddy will prove as valuable for tea plantations as the hills jutting into the valley of Brahmaputra have already become. Tea is already produced in large quantities in the hills to the east and north-east of Mandalay. With a continually moist and tropical climate, and country easily irrigated from the hill streams, there is no

reason that crops should not be grown all the year round.

The pass over which the present track from the Hookong Valley into the Brahmaputra Valley is carried, has lately been visited by Colonel Woodthorpe, who found it to be only 2,860 feet above sea level. Makum, in the Brahmaputra Valley, must be somewhere about 500 feet above the sea. The ascent from Makum to the top of the pass would therefore be about 2,400 feet, and the descent to the Nong Yong Lake which lies on Irrawaddy side of the pass is only 1,300 feet. Mr. Jenkins, who crossed the pass in 1869, says that the ridge "could be crossed five or six hundred feet lower by making a slight bend to the westward of the present path." This would reduce the level of the pass from 2,860 feet to about 2,308 feet. From the Nong Yong Lake there is a gradual descent of 460 feet to the great Hookong Valley, which is simply waiting the arrival of peace and population to prove one of the most productive and wealth-producing regions of our Indian Empire.

To the north of this pass, over which we propose to carry the railway, the hills rise to a height of 12,000 and 15,000 feet, and are snow-clad for a great part of the year. To the south they extend gradually, spreading into intricate masses of hills, which throw out a huge buttress into the Brahmaputra Valley for some 300 miles, forming the Garrow and Nagar Hills. To the south of this outflank they embrace, with a multitude of parallel cross spurs, the plateau of Munipur.

The whole country neighbouring, and to the south of Munipur between the sea-board and the Irrawaddy River is one mass of these parallel ranges, with here and there a little highland plain, the delta of a river, and scattered fringes of lowland, bounded by spurs, jutting to the sea-board or river. It is thus evident that, even leaving the crossing of the rivers aside, it will be much less expensive and much less difficult to carry a railway from Bhamo along our proposed route to Makum, and thence down the Brahmaputra Valley, than it would be to carry one from Calcutta or Chittagong across the hills anywhere to the southwards of the Hookong Valley. But when we consider that at no place below the junction of the two main branches of the Irrawaddy is it less than three-quarters of a mile in breadth, and that at our proposed crossing above Bhamo, it is reduced in the Tsenbo defile to 50 yards in breadth, it is superfluous to say that the construction of the railway along the route proposed by Mr. Colquhoun and myself will ultimately, and it is to be hoped speedily, be carried out. This railway is not only required for strategic purposes, but for the opening up of the resources and the civilisation of the country it will pass through, and I consider that its claims upon the Government are paramount to any others. The country through which it will pass must be entirely brought under our rule. When the railway is made, population will stream into this country from China, Lower Burmah, and from Bengal. Peace and population is all the country requires; our rule and the construction of railways will develop it into one of the richest mining, agricultural, and tea-growing countries in the world.

There are three other railways much required in Burmah, one proposed by me several years ago, for the connection of Henzadah with our seaport of Bassein, to open up a wealthy but land-locked part of the country. This has lately been surveyed, and could be commenced at once if the Government chose to supply the funds. Another from Sagaing up the Chindwin valley, with a branch up the basin of the Moo river, which would open up a vast tract of fertile and well-populated country, and enable us to get a firm grip upon the central portion of Upper Burmah, and maintain it with one-third of the force required at present. A steam launch, according to Mr. Bryce, takes three weeks during the dry season to reach Kendat from the mouth of the Chindwin, a distance of barely 250 miles, and above that town even a launch cannot proceed. And the third a branch line from the Rangoon and Mandalay Railway to proceed *viâ* Shwaygyeen and Beeling to our seaport of Maulmain, and thence to the Siamese frontier. If this line, which has been proposed for many years by Mr. Colquhoun and myself as a base for the connection of India with Siam and China *viâ* the Siamese and Burmese Shan States, had been made, the most serious rebellion that has happened in recent years in British Burmah, would either never have occurred, or would have been quelled long before it had gathered strength.

If we wish to extend our trade in Northern Burmah, railways are an absolute necessity. Unbridged roads are useless in the rains, and, for carriage beyond a few miles, next to useless in the dry season. The cost of carriage for our commissariat in Upper Burmah, away from steam navigation, according to the last


Map of
INDO-CHINA
showing proposed
BURMA-SIAM-CHINA RAILWAY.
Railways
Open for Traffic shown thus
Proposed British " "
Proposed Burma " "
Siam and China " "
English Miles
25 50 100 200 300
Lhassa
Sanpo or Brahmaputra
Darjeeling
Sadiya
Dibrugarh
PROPOSED BURMA AND INDIA RAILWAY
INDEPENDENT TRIBES
INDIA
Cherra Poonjee
Cachar
Tropic of Cancer
Comilla
CALCUTTA
Mouths of the Ganges
Chittagong
Akyab
BAY OF BENGAL
Ramree Id.
Cheduba Id.
BURMA
Bhamo
Mandalay
Myingyan
Pagan
Meaday
Prome
Pegu
Rangoon
Bassein
C Negrais
Mouths of the Irrawadi
Gulf of Martaban
MAULMAIN
Moscos Ids.
Tavoy
Mergui
Mergui Archipelago
Andaman Islands
Port Blair
INDIAN
BURMESE SHAN STATES
SHAN STATES
Zimme
Lagong
Raheng
Phitsanoulok
SIAM
Ayuthia
Bankok
Korat
Kabin
Ubon
Bassak
Luang Phrabang
Mekong
Ho-kham
Vien-Chan
Pon-Pissai
Pnom
Khemarat
Ancor
Battambong
Siemrab
Bien Ho or Tale Sap
CAMBODIA
Udong
Pnom-penh
Kampot
Kampor
Koh Tron
Camboja Pt.
FRENCH COCHIN CHINA
ANAM
TONQUIN
INDEPENDENT TRIBES
GULF OF SIAM
Isthmus of Kraw
Junkceylon
Pulo Tantalam
Steamer's Track
Quedah
Pulo Penang
Wellesley
Kelantan
MALACCA STRAIT
Dindings
Perak
Salangor
Acheen
MALAY
YUNNAN
CHINA
Chung Ching Fu
Chao-tung
Tang-chuan
Yun-nan
Ning-yuan
Meng-hua
Ta-lin
Kai-hua
Lin-an
Man-hao
Lao-kai
Puerh
Ssumao
Kiang-hung
Kiang Tung
Kiang Khong
Luang Prabang
Li-Sien R.
Yang-tse-kiang
Kinsha R.
Salween R.
Menam R.
PROPOSED
90 95 100 105
25 20 15 10 5

STATEMENT A.—*Showing direct loss or gain to Indian Government if £40,000,000 a-year were borrowed at 3½ per cent. every year, for ten years, for the construction of Railways in India.*

The nett earnings of the Railways constructed in each year, commencing two years afterwards at 1 per cent., and increasing 1 per cent. per annum until, in the 8th year, they reach 5·8 per cent., the average interest now earned by Indian Railways.

Years.	Interest due.	Net earnings per cent.										Total earnings each year, = per cent. × by £400,000.	Deducting earnings from Interest. Loss.	Deducting Interest from earnings. Gain.	Remarks.
		1st year.	2nd year.	3rd year.	4th year.	5th year.	6th year.	7th year.	8th year.	9th year.	10th year.				
	£											£	£	£	
1st	1,400,000	...	...	...	...	...	...	...	...	...	...	...	1,400,000	...	Railways commenced.
2nd	2,800,000	...	...	...	...	...	...	...	...	...	...	...	2,800,000	...	
3rd	4,200,000	1	...	...	...	...	...	...	...	...	...	400,000	3,800,000	...	First year earning 1 per cent.
4th	5,600,000	2	1	...	...	...	...	...	...	...	...	1,200,000	4,400,000	...	
5th	7,000,000	3	2	1	...	...	...	...	...	...	...	2,400,000	4,600,000	...	
6th	8,400,000	4	3	2	1	...	...	...	...	...	...	4,000,000	4,400,000	...	
7th	9,800,000	5	4	3	2	1	...	...	...	...	...	6,000,000	3,800,000	...	
8th	11,200,000	5·8	5	4	3	2	1	...	...	...	...	8,320,000	2,880,000	...	
9th	12,600,000	5·8	5·8	5	4	3	2	1	...	...	...	10,640,000	1 960,000	...	
10th	14,000,000	5·8	5·8	5·8	5	4	3	2	1	...	...	12,960,000	1,040,000	...	Railways completed.
11th	14,000,000	5·8	5·8	5·8	5·8	5	4	3	2	1	...	15,280,000	...	1,280,000	Nett earnings exceed interest.
12th	14,000,000	5·8	5·8	5·8	5·8	5·8	5	4	3	2	1	17,600,000	...	3,600,000	
13th	14,000,000	5·8	5·8	5·8	5·8	5·8	5·8	5	4	3	2	19,220,000	...	5,220,000	
14th	14,000,000	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5	4	3	21,040,000	...	7,040,000	
15th	14,000,000	5·8	5·8	5 8	5·8	5·8	5·8	5·8	5·8	5	4	22,160,000	...	8,160,000	
16th	14,000,000	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5	22,880,000	...	8,880,000	
17th	14,000,000	5·8	5 8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	23,200,000	...	9,200,000	
18th	14,000,000	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	23,200,000	...	9,200,000	
19th	14,000,000	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	23,200,000	...	9,200,000	
20th	14,000,000	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	5·8	23,200,000	...	9,200,000	
	217,000,000											256,900,000	31,080,000	70,980,000	Nett gain, £39,900,000.

NOTE.—If £20,000,000 a-year, instead of £40,000,000, was expended by Government, the nett gain on that sum would be, in the 20 years, £19,950,000. If the other £20,000,000 was expended by Guaranteed Companies, the nett loss on that sum, in the 20 years (see Statement B), would be £16,200,000. If these two expenditures were concurrent, the nett gain, in 20 years, on the gross expenditure of the £400,000,000, would be £3,750,000, and a clear yearly gain of £5,400,000 would accrue to the Government after the 20th year.

STATEMENT B.—*Showing loss or gain to Indian Government if £20,000,000 a year were expended upon the construction of Indian Railways for ten years, by Companies under a Guarantee of 3½ per cent. interest.*

The earnings of the Railways constructed in each year, commencing two years afterwards at 1 per cent., and increasing 1 per cent. per annum, until, in the 8th year, they reach 5·8 per cent., after which Government receives half the earnings over 5 per cent., which, assuming the Railways pay 5·8 per cent., the average interest paid at present by Indian Railways, would be 0·4 per cent. per annum.

Years.	Gross Interest not deducting Earnings.	Nett Interest lost by Government on Expenditure of £20,000,000 a year.										Yearly Loss.	Nett Interest gained by Government on Expenditure of £20,000,000 a year.										Yearly Gain.	Nett Loss.	Nett Gain.	Remarks.
		1st year.	2nd year.	3rd year.	4th year.	5th year.	6th year.	7th year.	8th year.	9th year.	10th year.		1st year.	2nd year.	3rd year.	4th year.	5th year.	6th year.	7th year.	8th year.	9th year.	10th year.				
	£											£											£	£	£	
1	700,000	3½	...	...	...	...	...	...	...	...	...	700,000	...	...	...	...	...	...	...	...	...	...	...	700,000	...	
2	1,400,000	3½	3½	...	...	...	...	...	...	...	...	1,400,000	...	...	...	...	...	...	...	...	...	...	...	1,400,000	...	
3	2,100,000	2½	3½	3½	...	...	...	...	...	...	...	1,900,000	...	...	...	...	...	...	...	...	...	...	...	1,900,000	...	First year's railways earn 1 per cent.
4	2,800,000	1½	2½	3½	3½	...	...	...	...	...	...	2,200,000	...	...	...	...	...	...	...	...	...	...	...	2,200,000	...	Second ,, ,, ,, 1 ,,
5	3,500,000	½	1½	2½	3½	3½	...	...	...	...	...	2,300,000	...	...	...	...	...	...	...	...	...	...	...	2,300,000	...	Third ,, ,, ,, 1 ,,
6	4,200,000	...	½	1½	2½	3½	3½	...	...	...	...	2,300,000	...	...	...	...	...	...	...	...	...	...	...	2,300,000	...	First ,, ,, ,, 4 ,,
7	4,900,000	...	...	½	1½	2½	3½	3½	...	...	...	2,300,000	...	...	...	...	...	...	...	...	...	...	...	2,300,000	...	,, ,, ,, ,, 5 ,,
8	5,600,000	...	...	...	½	1½	2½	3½	3½	...	...	2,300,000	·4	...	...	...	...	...	...	...	...	...	80,000	2,220,000	...	,, ,, ,, ,, 5·8 ,,
9	6,300,000	...	...	...	...	½	1½	2½	3½	3½	...	2,300,000	·4	·4	...	...	...	...	...	...	...	...	160,000	2,140,000	...	,, ,, ,, ,, 5·8 ,,
10	7,000,000	...	...	...	...	...	½	1½	2½	3½	3½	2,300,000	·4	·4	·4	...	...	...	...	...	...	...	240,000	2,060,000	...	Railways completed.
11	7,000,000	...	...	...	...	...	...	½	1½	2½	3½	1,600,000	·4	·4	·4	·4	...	...	...	...	...	...	320,000	1,280,000	...	
12	7,000,000	...	...	...	...	...	...	...	½	1½	2½	900,000	·4	·4	·4	·4	·4	...	...	...	...	...	400,000	500,000	...	
13	7,000,000	...	...	...	...	...	...	...	...	½	1½	400,000	·4	·4	·4	·4	·4	·4	...	...	...	...	480,000	...	80,000	Nett earnings exceed interest.
14	7,000,000	...	...	...	...	...	...	...	...	...	½	100,000	·4	·4	·4	·4	·4	·4	·4	...	...	...	560,000	...	460,000	
15	7,000,000	...	...	...	...	...	...	...	...	...	...	...	·4	·4	·4	·4	·4	·4	·4	·4	...	...	640,000	...	640,000	
16	7,000,000	...	...	...	...	...	...	...	...	...	...	...	·4	·4	·4	·4	·4	·4	·4	·4	·4	...	720,000	...	720,000	
17	7,000,000	...	...	...	...	...	...	...	...	...	..	...	·4	·4	·4	·4	·4	·4	·4	·4	·4	·4	800,000	...	800,000	
18	7,000,000	...	...	...	...	...	...	...	...	...	...	...	·4	·4	·4	·4	·4	·4	·4	·4	·4	·4	800,000	...	800,000	
19	7,000,000	...	...	...	...	...	...	...	...	...	...	...	·4	·4	·4	·4	·4	·4	·4	·4	·4	·4	800,000	...	800,000	
20	7,000,000	...	...	...	...	...	...	...	...	...	...	...	·4	·4	·4	·4	·4	·4	·4	·4	·4	·4	800,000	...	800,000	
	108,500,000	Gross loss										23,000,000	Gross gain										6,800,000	21,300,000	5,100,000	Nett loss, £16,200,000.

Blue-book, varies from 17 annas a ton per mile in the dry season, to 3 rupees a ton in the rains, or from 68 to 192 times the freight charge for the carriage of grain on the Rangoon and Toungoo Railway. How can trade be expected to increase and prosper under such unfavourable conditions? Even if good bridged and metalled roads were made, cart hire would be about 4 annas per ton per mile, or 16 times the cost of carriage by railway. Upper Burmah is at present without railways, roads, or bridges; all of these are required—railways for long distances, and bridged roads for feeders to the rivers and railways—before we can bring the blessings of peace and prosperity to this rich but long misgoverned country.

In conclusion, I will beg you all to take what I have said to you this evening to heart. Mr. Colquhoun and I have done our best for years to rouse public attention to the absolute necessity of acquiring new markets for our trade; at last the necessity is realised through the length and breadth of the land. We have succeeded, after exploring, surveying, and studying the various trade routes between India and China, in tracing out the best route for the connection of these two populous and, in every way, rich countries, which contain together some 600,000,000 of inhabitants, or far more than a third of the population of the world.

Upper Burmah is now our territory, and the Shan States, which have been feudatory to it for centuries, must be controlled, if not administered, by us. Our road to China lies through these States, the only practicable route by which a railway can be constructed to connect it with India, a route which has been known as the "gold and silver road of trade" for ages, a route which the Shan chiefs of Kiang Hung and Kiang Tung begged Macleod in 1837 to ask the Indian Government to have opened up for mutual trade. It is for us to see that our interests in this important matter are not lost sight of, that the means for opening up China to our trade are not recklessly disregarded for the sake of present ease, or from cheeseparing economy.

New markets we must have. China and India are the largest and most populous unopened and civilised markets in the world. It is for us, and chiefly for our merchants, manufacturers, and workmen—the people now suffering, or threatened with now impending disaster—to see that every effort is made to enable us to secure fresh customers by opening out these new fields for our commerce.

With Continental markets closing against our goods, and our former customers competing with us throughout the world, there exists no other way for the future expansion of our trade. If we fail to extend our commerce in the directions I have pointed out, the output of our manufactures must be diminished, and our population be reduced by starvation, or by some vast Government scheme of emigration.

I ask you all to consider this matter carefully, to ponder over it, and to talk it over with your friends. The more you look into it, the more interesting it will become to you. It involves the misery or happiness of the vast body of our population, together with the rise or fall of the prosperity of our country.

DISCUSSION.

Mr. HYDE CLARKE said they were much indebted to Mr. Holt Hallett for an exposition of the subject of railways, not only in Burmah, but in India also, but he had introduced some hypothetical statistics which weakened rather than strengthened his case. Comparisons between American rates of profit, and those of other countries, rested on a fallacy. Although they had plenty of books and statistics, no one knew what the profit on American railways was, because they had not the figures, but they did know the rates on the Indian railways, thanks to the admirable statistics prepared by the Government officers, but with regard to the United States and many other countries, the figures quoted were altogether fallacious as a means of comparison. He might illustrate that by reference to another remark in the paper, viz., the comparison between the trade in cotton produce with India and with the United States. Having referred to the large quantities of these goods taken by India and Burmah, Mr. Hallett said the United States only took £1,400,000 worth out of a total of £65,000,000; but he apprehended this was only an illustration of the old saying that the import of coals into Newcastle was unlikely to be large. With regard to the silver question, many of Mr. Hallett's remarks were very apt, but it was a very difficult and dangerous question, especially in connection with India. It was said that if such and such railways were carried out, they would use up the production of silver during so many years, which would cause very great embarrassment. He had hoped that doctrine had been abandoned, for it was perfectly clear that it was the large mass of silver which constituted the currency, not the quantity produced from year to year, which had really to be considered. The production of silver at the present moment was carried on at a cheaper rate than it was at the time of the discovery of California, and was now

equivalent to not more than 3s. 6d. per ounce instead of 5s. as it was then, and the tendency seemed to be in a downward direction. Under these circumstances, it was very difficult to predict what the future of silver would be, or to establish a permanent standard for it. In an early part of the paper, Mr. Hallett said that if the £400,000,000 which had been supplied by this country to the United States had been applied to India, it would have been very much more to the benefit of this country, and that no doubt was the key to the whole question; but the conclusion he should draw from it was this. If the Government of India had been as wise as the people of the United States, and had applied for money in the markets of Europe on the terms on which it could be obtained, then India would have had not only the capital it now had, but far more, and it would have had that capital on better terms. It was because the Government of India had been always going against experience, and against the market, that it had failed to avail itself of the ample means at its disposal, whereas the United States, which had taken advantage of its opportunities, was able to show an expansion of railways with which India had nothing to compare. With regard to the amount for assumed loss on Indian guarantees embarrassing the revenues, he would remind them that the greater body of English railways had put interest during construction to capital account, thereby reducing the apparent charge. He had had some experience in these matters in various countries during the last half century, and must say that it was of the greatest importance to India, that the experience of that country alone should not be attended to, but that of those countries which offered the best examples of railway making should also be availed of. On the whole, he quite agreed with the view Mr. Hallett had put forward, and it was impossible to exaggerate its importance to India and to the people of this country.

Mr. Edmund Kimber was surprised to hear the statement that the statistics of American railways could not be relied upon. Poore's Railway Manual, which was published every year in New York, was one of the most carefully compiled publications on the subject, and in that you could find not only full particulars as to those which paid, but also those which did not pay; and the statistics bore out conclusively what Mr. Hallett had said as to the United States railways, viz., that the average dividend in 1884 was 4·4 per cent. He thought, however, that Mr. Hallett had drawn rather a wrong inference with regard to the Indian railways in saying that, taking the rupee at 1s. 6d., they paid only 4·3 per cent. Lord Cross said the other day that the dividend was £5 12s. 6d., and he did not see how the price of the rupee made any difference, as the dividend and capital were reduced alike. In his opinion, the dividend was still £5 12s. 6d., and was likely to go on increasing. Mr. Hallett had understated his case with regard to the Indian railways, as against both Liberal and Conservative Governments. There were no party politics in that room, and he was sorry to say that both sides of the House of Commons were equally to blame in this matter. It was most disgraceful that when, after an agitation such as Mr. Hallett was now engaged in, some few years ago an Indian Railway Committee was appointed, which, after an exhaustive inquiry, made a report, whose recommendations were embodied in an Act of Parliament, authorising the Government to raise and spend £10,000,000 on railways, it was taken no further notice of by either the Liberal Government or the Conservative one which succeeded it. The fact was that members of the Legislature acted not on Imperial principles, but on the principles of bumbledom and vestrydom. The chaff levelled by Ministers against independent M.P.'s, at the end of every Session in the debates on the Mutiny Act, was that "they surveyed mankind from China to Peru." The world had now become so small in consequence of railways and telegraphs, that Mr. Hallett had been able "to survey it almost from China to Peru;" and his remarks had been attentively listened to in that room. But unfortunately that was not the case in Parliament. There gentlemen raised questions about the police in Cork, or about some workhouse in the East-end, and tremendous discussions on little questions like that occupied more than half the time every night, to the disregard of the vast acquisitions for which the country was responsible, and of the empire on which it was the boast of Englishmen that the sun never set. Perhaps the Chairman could explain how it was that, after this Act of Parliament had been passed, not a farthing had been expended. True, a guarantee had been given for the Indian Midland Railway, on which £600,000 had been subscribed, and now they were thinking of giving a similar guarantee for the Nagpore Railway.

Mr. Martin Wood said it had been given.

Mr. Kimber said he was glad to hear it. The reporter ought to take a note of it. The Chinese were now making great progress in railway making, and between two and three thousand miles had been surveyed. It was very necessary that the Chinese and English should form a coalition to defend each other in case of a Russian attack, and that could only be done by uniting their forces in Burmah and China. Mr. Hallett had very ably pointed out the effect which would be produced in opening fresh markets, but the one thing certain beyond anything else was that it would bring about a political and patriotic union between the people of the two States, and it would be nothing less than a crime if Mr. Hallett's advice was not attended to.

Mr. Magnus Mowat remarked that a great deal of what he might have said had been anticipated by the comments of Mr. Hyde Clarke. The present was a very opportune time for bringing forward a

leading subject like that of railway extension in India. Only the previous day the Bengal-Nagpore was put on the market, and in three hours' time the capital was subscribed more than three times over. This clearly showed that there was no lack of money when a fair investment offered. He could not, however, follow Mr. Hallett in all his figures. It was too much to suppose that India could be covered with railways in the same way that Great Britain was. He thought the £10,000,000 recommended by the House of Commons Committee, or even more, might be profitably expended. He supposed there must be some mistake as to the traffic figures on the Rajputana line put forward by Mr. Holt Hallett; he had had occasion to go into details of the foreign trade of India, and was of opinion it did not exceed 6,000,000 of tons, and yet Mr. Hallett said that on this single line over 300,000,000 of tons were carried. Perhaps he meant the mileage tons.

Mr. HALLETT said that was the explanation.

Mr. MOWAT added that the silver question was a most intricate one. He had watched it closely for many years, and although the low point the rupee had touched pressed heavily on many interests in India, on the other hand the cultivator and the great mass of the people had gained. It had been the means of stimulating the wheat trade, in which India stood second only in magnitude to the United States of America, and he might add of the general export trade of the country as well. The low value of silver had an important bearing on the internal trade, which, thanks to the extension of the railway system, was growing more rapidly than the foreign trade. He questioned whether India, as an outlet for Lancashire goods, would go on increasing at the pace many supposed, because India was now becoming a great manufacturing country, and was competing with Lancashire in China, Japan, Arabia, and many other places. Last year India manufactured no less than 620,000 bales of raw cotton, and in a short time the quantity is likely to be greatly increased. The raw material used in Lancashire was not more than 3,500,000 of bales.

Mr. BRYCE thought the deficiency of railway communication in India was not to be laid entirely at the door of the Government, because the reductions in rates which had led to so great an improvement in the returns during recent years had been brought about to a great extent in consequence of the influence of the Government acting on the chambers of commerce and merchants. The great obstacle to these reductions had been the obtuseness of railway directors themselves sitting in London, having long left the country, and not realising the real necessities of the people. With regard to the action of the Government in late years, he would point out that the scare which arose with regard to a threatened war with Russia led to so much expenditure in India that it was not prudent for the time to expend the large sums recommended by the Committee of the House of Commons. Still he must admit that both parties in the State were to blame in not recognising the necessities of India. Both Mr. Mowat and the Chairman, with whom he had woiked in Bombay, must remember how disheartening it was to attempt by some such surgical operation as was said to be necessary to make a Scotchman understand a joke, to get the very simplest commercial ideas into the heads of Government officials. A great deal of that, however, was now past, and at the head of many of the railways in India were very able men, such as Major Bissett, of the Rajputana line, who appeared to be doing their best; both by reduction of fares and branch extensions, to develop the resources of the country. Having some special knowledge of Burmah, he might say a word or two on that part of the paper. Mr. Hallett had perhaps a little overestimated the rapidity with which a line up the valley of the Brahmaputra, and into Upper Burmah, would turn out profitable, because the country would be for many years in such a state that it would be improbable that population would be rapidly attracted towards it. The large increase in the population of Lower Burmah was due not to normal causes, but to migration from Upper Burmah, where the misrule of King Theebaw and his father had driven out the people. At the same time it was quite true that by and by these regions would attract population, and he was quite right in the picture he drew of the resources of the country with regard to mines, tea plantations, and so on. He had seen splendid tea growing in the Chindwin valley, but there it was not dried as in China and India, but pickled, and in this form was a favourite delicacy with the Burmese; indeed, the only ceremony of marriage amongst them was for the young couple to eat pickled tea together. There was one valley which he had the pleasure of visiting some six years ago, the Kubo valley, a long, narrow valley between the Chindwin and the first line of hills, about eighty miles long, by about ten miles wide; it was of exceeding richness, but owing to the raid of the Chins, and other wild tribes on the western side, had become almost uninhabited. The branch line proposed, by the Chindwin river, would open up that valley, and it would be a source of great wealth to the other parts of the country. On the whole there was quite sufficient to make them urge on the Government the importance of pushing on the construction of these railways as rapidly as possible, and what had been said about their necessity for political purposes was absolutely true.

Mr. MARTIN WOOD said that Mr. Hallett was evidently an enthusiast, which was no objection, but it was desirable to look at all sides of a question of such importance. He was entirely with him in principle in advocating the carrying out of public works in India, including railways, at a

time when silver and materials were cheap. So far back as 1883 he drew up a statement which he put before the Select Committee, showing that if the active promotion of productive works had been taken, the loss by exchange would have been minimised. But there was this difference between Mr. Hallett and himself; the former went in for railways, and nothing but railways; while his view was that the policy should be carried out in a much broader manner, water storage and irrigation works should have a far larger share of attention, and those railways should first be made which were likely to pay. Mr. Hallett was for constructing a line over the mountains, between India and Burmah, whereas, within India itself, there were many other routes which wanted attending to first, and unless there were the means to enable the people to grow crops, and water to secure them against the vicissitudes of the seasons, the railways would have nothing to carry. He thought it would convey a very wrong impression to speak of one quarter of the capital only being expended on materials, and the rest on construction in India. He believed the proportion spent on material would be very much larger, and another large part would go to English engineers and workmen, so that he doubted if more than a fourth would remain for actual disbursement amongst the labouring population of the country. The question of the rate at which the Government of India could proceed, required a far closer examination. Mr. Hallett spoke of the profits made, but in the budget for 1886-7, the net loss on the railways in India was put at £1,721,000, and he believed it had rather increased since then. Sir Auckland Colvin, the finance minister, in his statement, after alluding to the annual loss as £1,500,000, and saying the Government intended, in the next three years, to spend 27 crores, he said that as part of the railways under construction would leave little or no direct profit, a decrease in the loss on the railways could not be anticipated for some considerable time to come; but, on the contrary, it would probably be progressively greater for three or four years, not because the lines open for traffic were not paying, but, in spite of their increasing receipts, all they could yield was swallowed up by the interest on the capital of those under construction. The finance minister added: "In making a general estimate of the position created for us by the prosecution of our railway policy, and by the increase in our military expenditure, we cannot for some time to come look to our leading railway revenue to give any net gain upon our estimates; that all we can expect is, that they should lessen a loss; and that for the next two or three years even this relief will probably diminish, though, at a later stage, it should again make itself more felt." These were important considerations, which should be borne in mind by those who were so ready to approve of all railway exploitation in India. He was as thankful as any one for railways to be extended where they were likely to prove useful, but some of these gigantic schemes for railways over the mountains of Assam and Burmah were a very different thing, and the expense would be something frightful to contemplate, whilst the prospect of returns was entirely problematical.

Mr. KIMBER said he believed the loss on the Indian railways, alluded to in the budget, was because the income was debited with the capital expenditure.

Sir JULAND DANVERS said he had come simply to hear opinions on a subject to which he had of course paid a good deal of attention, and his mouth was somewhat closed in consequence of his official position, so that he could only make a few general observations. He had generally had to hear at such meetings a certain amount of censure passed on the acts of the Government. If he were simply to say that the Government were faultless, his statement would possibly be received with incredulity, and it would take a longer time than was allowed to attempt an elaborate defence of the policy pursued for some years past. Still, no one connected with India, and with the operations of the Public Works Department, could fail to admit that the railways hitherto had been one of the greatest boons to the country, and had conferred incalculable benefits upon the people, and not only India had benefited, but England. The great difficulty with which the Government always had to contend was that of finance, and Mr. Hallett, in his enthusiastic desire to see railways extended, had treated that point rather too lightly. A great deal was being done, but not enough to meet the desires of all; and he did not mind confessing that he was amongst the number. Still it must be admitted that the Government was very much hampered by the financial condition of India; this was a matter which required the greatest attention, and in order to free it from anything like embarrassment, each year should be made, if possible, to show an equilibrium, if not a surplus, and that could not be done if they went on too fast with the guarantee system. That involved the liability to pay a large sum in England every year, in sterling, and £3,000,000, the sum now disbursed in England, on this account, involved the payment by the taxpayers of India of about four crores. He might be met by the observation that railways helped to develop the country, and to increase the revenue, and he was the first to admit it, but they must go by degrees, or disaster might ensue. Mr. Hallett had ably advocated the extension of Burmese railways, and their connection with the system of India, by means of a line across the hills to the Brahmaputra. It would be rash to say that such a line might not be accomplished within a certain time, but it should be undertaken with caution, and by degrees. The connection was being made to Mandalay, and he hoped soon it

would get to Bhamo; but the first condition of the extension of a railway should be the probability of its paying; in fact, the paying quality of a line was the best test of its value. There were so many districts in India which required development, that it was difficult to say which should be attended to first. With regard to the observation of Mr. Kimber on the Indian Midland Railway, he might say that the guarantee was to the extent of £6,000,000, and the amount as yet subscribed was £3,000,000. The same observation applied to the Bengal and Nagpore line; £6,000,000 was the total capital, and £3,000,000 had been already subscribed. There, again, the Government had involved itself in a liability which represented a considerable annual sum, which would have to be paid in sterling, in the face of the low price of silver. He would not venture to touch on that subject, but he quite agreed with Mr. Hallett in his advice that we should ponder over this question seriously, and talk it over with our friends. They were much indebted to him, and his coadjutor Mr. Colquhoun, for the able and indefatigable way in which they had conducted the examination of this subject.

The CHAIRMAN, in proposing a vote of thanks to Mr. Hallett, said all would agree that this was a most deeply interesting paper. He thought the remarkable success which attended the lectures given by both Mr. Colquhoun and Mr. Hallett was due to the fact that they appealed not only to the pockets, but also to the imagination of Englishmen, and thus they had succeeded in a wonderful way in enlarging the horizon of the commercial classes, and in arousing the public sentiment of England to a knowledge of the immense capabilities of a country like Burmah. In this way they had reconciled the public opinion of this country to the annexation of Burmah, in spite of the prejudice which had so long existed against any extension of empire. Mr. Hallett had spoken that evening of the means of strengthening their connection with Burmah, and making it a half-way house for opening up overland communication between India and China, which would be of great benefit to both countries, and also to the commerce of England. It must strike every Englishman with a feeling of humiliation that so little had been done by this country to open up the great continent of Asia by railway communication. As compared with Russia, we had done little or nothing in opening up overland communication across Asia. Russia had pushed forward an overland line through countries which were supposed to be impassable deserts, and had actually completed the line up to the frontier of Afghanistan, but meanwhile, though fifteen years ago a Committee of the House of Commons recommended that India should give a guarantee for the construction of the Euphrates Valley line, not a single sod of that railway had yet been turned, and we had only a few miles of railway creeping foot by foot beyond the frontier of India up towards Quettah and Candahar. That was only one example of the way in which the people of this country seemed of late years to have lost their old faculty of taking the initiative both in politics and commerce, but unless they were able to resume the initiative, so surely would they see the decline of this great empire. He would not say that their duty had been altogether neglected, though no doubt the extent of railway communication in India seemed excessively small when compared with that of Europe, or still more of America. When there was a population in India five times as great as that of the United States, whilst the railway system of America was ten times as large as that of India, and in America as many miles of railway were constructed in a year as equalled the whole Indian system, one could not help feeling that our progress had not been what it should. But the great defence of the Indian Government was this, that in America and in our Colonies, which piled up debt for railways year after year in the most reckless fashion, you had a self-governed people who spent their own money, and were ready to take all these burdens on themselves for the sake of developing the resources of the country, but in India we were an alien Government, one of whose most pressing obligations was not to extend taxation beyond a certain point for fear of provoking the hostility of the population. Mr. Kimber had referred to some Act of Parliament authorising the expenditure of £10,000,000 sterling on Indian railways alone. He had never heard of such an Act, but he knew that the Committee of the House of Commons in 1885, like the previous Committee presided over by Mr. Fawcett, carefully guarded itself by saying that no capital was to be expended on Indian railways which would have the effect of increasing the taxation of the people. That was the limit always placed on expenditure, and that was why the Government of India last year, when compelled to spend a large sum on the frontier railways for purposes of defence, were compelled to suspend the construction of productive railways in the interior. He did not think that was altogether a farsighted policy, and thought more freedom should have been given to the Government of India, for it was quite evident that by suspending the construction of productive railways you debarred the country from raising revenue which might be of the greatest value in future years. The great fault of the administration in India was that the Government had no distinct continuous system for the construction of these public works. At one time it went in for guaranteed companies, at another for making the railways itself, and at another again for some intermediate plan. When the Government took anything in hand, directly any urgent pressure arose in any particular quarter, important public works elsewhere were stopped, and thus much money was wasted, because works were not continuously carried out. That was a defence of the employment of a guaranteed company lately resorted to by Lord Randolph Churchill, with regard to the

Indian Midland line, and more lately by Lord Cross with regard to the Nagpore line. In some respects it was better to employ companies to do the work with a guarantee, because whether there was a state of peace or war, they would go on steadily, and the line would more quickly be in a position to yield a revenue. There was not much reason to complain now of the way in which the Government was going on. Sir John Gorst had just stated that there would be between 1,100 and 1,200 miles of new railway opened during the present year in India, at an expenditure of something like £9,000,000 sterling; and it must always be borne in mind that the expenditure must not largely exceed the revenue of the empire. With reference to the silver question, he would say this. Mr. Hallett had proposed that a very large sum—some hundreds of millions—should be raised for the immediate construction of a vast system of railways, which would lay upon the Indian exchequer a further expenditure of £3,000,000 a year; but he said that would not be so much as the money now lost by exchange, and that the expenditure would have the immediate effect of raising the rate of exchange, and so saving this great loss. He had, however, overlooked one consideration, viz., that it was the very cheapness of silver at the present moment which induced the traffic, and so made the railways pay, as they had done during the last few years. If the exchange were again suddenly raised, it would cease to be profitable to the Indian grower to export his wheat, because he would not be able to sell it except at a price 20 or 30 per cent. higher than at present, and thus he would lose his market and the Indian railways their traffic. Any sudden raising of the ratio of silver to gold might produce a convulsion in India which would be far more disastrous to the people of this country than any they had experienced from the depreciation of silver, for the cheapness of silver had been an immense benefit to the people of India. A Blue-book had just been issued giving the annual returns of the trade of India, from which it appeared that, whtle the export trade during seven years had increased by 22 per cent., the imports had increased 33 per cent. Thus, owing to the cheapness of silver, India was getting a much larger return for her exports than she did in former years. Last year India bought a very much larger quantity of Lancashire piece goods than in any preceding year, although they were now manufacturing such large quantities themselves. With regard to railway construction in Burmah, there was an interesting paper in the latest Burmese Blue-book, showing on the best authority, after careful inquiries made by engineers, that it was cheaper to construct and work railways there than to construct and keep open good roads. Hitherto the bias of opinion had been the other way; it was said you should begin with roads and go on to railways, but it was shown conclusively that there it was cheaper to make railways first, that it was far better to make a railway to Mandalay, than to begin by making roads, which would cost a large amount to keep open. Railways were admitted to be a great stimulus to commerce, and he looked with much hopefulness on the prospects of the extension of railways in that part of the world. The India-office, at the present moment, was showing very great spirit; Lord Cross seemed to have thoroughly grasped the question, and to be anxious to do everything he could to extend the railway system. Mr. Hallett's proposal for carrying a railway through from the Brahmaputra valley to the Irrawaddy might seem, to some persons, rather a wild scheme at the present moment, but it would soon become practicable. We ought to imitate our rivals the Russians, who showed much more imagination, and much greater practical capacity, in the extension of railways, and in opening new markets for their goods, than this great commercial country. We annexed all these rich territories, and were yet afraid to construct a few miles of railway to connect India and Burmah, and to open up the great empire of China. He had no doubt that, in a few years, the practical results of Mr. Hallett's ideas would be seen, and it would then be recognised that he was now only a little in advance of his age.

Surgeon-Major PRINGLE seconded the vote of thanks, and said that railways were indispensable to new markets, for in their absence you would never get beyond the ordinary native market. He had lived for twenty years beside the East India Railway, and watched its progress, and he had more than once said to himself that the railway system would either make or break India. It would make it, if by a scientific and economical mode of construction the resources of the country were developed; but it would break it, if the money necessary to pay the interest were taken in taxation from the agriculturist, forcing him more and more into the hands of the money lender. Then it would enrich the money lender at the expense of the cultivator, who would be forced to lose all rotation of crops, because the money lender made him pay so heavily that he was compelled to grow what fetched the most money, until the land became utterly exhausted.

The vote of thanks was carried unanimously.

Mr. HOLT HALLETT, after returning thanks, stated, in reply to Mr. Kimber, that in the summary of the Administration Report on Railways in India for 1885-6, the capital of the railways is given at the conventional exchange of 2s. to the rupee. The net earnings, excluding steamboats and suspense items, are stated as £5 16s. 8d., or 5·8 per cent. The question as to the true earnings is very complex, the railways having been constructed during a time of greatly varying exchange, and a large amount has to be paid in England in interest at the rate of 2s. to a rupee. He had been unable to find in the Government accounts the true amount of interest paid, but it most likely

lies about half-way between the 5·8 per cent. and the 4·3 per cent. It would be well if the accounts were so kept as to allow the public to arrive at a just conclusion on the matter. He had taken the lowest possible value in order to save himself from the charge of exaggeration. In answer to Mr. Hyde Clarke's remarks, he failed to see how £300,000,000 could be expended in silver on railways in India without the Government purchasing and coining the silver, thus increasing the currency to that amount. In his opinion it did not matter how cheaply silver could be mined, as there is only a limited amount of veins from which it can be extracted. As to the Chairman's fears respecting the effect that the rise in the value of silver might have on the export of Indian wheat, he would call his attention to the fact that no mills were at present existing in the wheat-producing districts, and the wheat was sent to the ports with 20 or 30 per cent. of rubbish. If the price of wheat fell, mills would doubtless be built, grain would be reduced in weight before instead of after it had been transported by railway, it would be dispatched in bulk instead of bags, and the appliances now in use in America, which so greatly reduced the cost of handling grain, would doubtless be brought into use. Necessity is the mother of invention, and he had no doubt that India with the rupee at 2s. could not only compete with, but drive the American wheat out of our markets. Mr. Bryce need not fear about immigrants neglecting a rich field like Upper Burmah, even though a little disturbance might be going on for a few years. Stuchuan had its population destroyed in the middle of the 17th century; it was immediately colonised from Hupeh and Hunan, and now has 35,000,000 inhabitants. Kuei-chow and Yunnan were rendered desolate in the rebellions which ceased about 1874; they now contain about 11,000,000 of people, who have poured in, and are still pouring in, from the provinces to the east of them.

FOREIGN & COLONIAL SECTION.

Tuesday, March 1, 1887; Sir SAUL SAMUEL, K.C.M.G., C.B., Member of the Council, in the chair.

The paper read was—

THE COLONIAL AND INDIAN EXHIBITION.

By EDWARD CUNLIFFE-OWEN, C.M.G.

Some time previous to the opening of the Colonial and Indian Exhibition, I was honoured by an invitation from the Council of the Society of Arts to read a paper upon this subject. I then excused myself on the ground that, at that time, it would have been impossible to collect facts of sufficient interest to warrant my undertaking such a task.

The Royal Commission had but just commenced its labours, and the Colonial and Indian Governments, while they had intimated their intention of participating in the Exhibition, had not afforded sufficient information to enable any idea to be formed as to the extent or character of their displays. Such a paper could therefore only have hazarded surmises as to the probable contents of the Exhibition, and would have been purely conjectural in its character; nor did I feel myself competent to deal with the subject from this point of view. Indeed, had the reading of such a paper been delayed until even within a few weeks of the opening of the Exhibition, I fear that any information respecting its contents would have baffled my powers of description, for it was only on the eve of the opening that order was evolved out of the seeming confusion which had hitherto existed, and that piles of packing-cases and armies of workmen vanished before the wonderful scenes which delighted and surprised millions of visitors during the summer months of last year.

I am afraid, on the other hand, that the details which I am now in a position to give you err on the side of staleness, for I doubt not that all my hearers bear vividly in their memories the leading features of the great Exhibition of last year; that they frequently visited it, and that they could, without effort, describe it as well, and, indeed, far better, than myself.

I must, however, in craving your indulgence, plead as my excuse that much benefit may be derived from constantly bearing the contents of the Exhibition in mind, from dwelling upon the wondrous examples of enterprise and skill which were displayed in it, and from meditating on the greatness of an Empire which has such boundless resources at its command.

It seems fitting that, before commencing the subject of this paper, a slight tribute should be paid to the Society, under whose auspices I have the honour of addressing you this evening, for the ready assistance it has accorded both to this Exhibition and to those immediately preceding it.

Throughout the past series of Exhibitions the Society has, through its Council, given its aid and advice whenever sought for, and it is impossible to over-estimate the value of the assistance rendered by it, or to adequately describe the material and moral support which, by its countenance, these undertakings have derived.

It has been the earnest aim of the promoters

of these exhibitions to follow, as closely as possible, the traditions of the Great Exhibitions of 1851 and 1862, in connection with which the Society of Arts played so distinguished a part. In extending, therefore, to these undertakings its support and encouragement, the Society of Arts has not only afforded to their organisers their best and ripest experience, but they have also confirmed them in the belief that their labours have tended to the advancement of art, science, and commerce.

The Colonial and Indian Exhibition has now been closed for a sufficiently long period to enable some ideas to be formed as to its permanent results; and it is my intention this evening, in addition to saying a few words on the origin of the Exhibition, the means that were taken to organise it, and a brief description of its contents, to hazard some remarks upon the benefits which must surely accrue both to the British colonies and India, and also to the mother country, by the gathering together of the products and resources of the outlying portions of Her Majesty's dominions.

It is scarcely necessary for me to remind you that this Exhibition owes its existence entirely to the foresight and exertions of the Prince of Wales. Not only was His Royal Highness the originator of the idea of its existence, but he was the centre around which its whole organisation turned; and the deep personal interest which the Prince of Wales took in everything relating to the Exhibition, from the highest questions of policy down to the minutest details of management, have deeply impressed all those who have had the honour of working under His Royal Highness's commands for the success of the Exhibition.

The origin of this Exhibition may be traced as far back as the year 1878, when, at the Paris Universal Exhibition of that year, the striking displays made by the Indian Empire and the British colonies gave evidence of the enormous strides taken by Greater Britain in the development of its boundless resources. His Royal Highness the Prince of Wales, then President of the British Commission, was much impressed with the extreme importance of the results of this development being also witnessed by the people in this country, and therefore gladly took advantage of the inauguration of the series of Exhibitions of which, it will be remembered, the International Fisheries Exhibition of 1883 was the first, and publicly announced at its close that the last of this series would take the form of an Exhibition devoted to the illustration of the products and resources of the British Colonial and Indian Empire.

The Imperial character of this undertaking rendered it desirable that a more formal organisation than those under which the previous Exhibitions of this series had been managed should be appointed to undertake its control and direction; and accordingly Her Majesty the Queen was pleased to issue a Royal Commission, of which His Royal Highness the Prince of Wales was Executive President, and Sir Philip Cunliffe-Owen was Secretary.

The Royal Commission was gazetted on the 10th November, 1884, and soon after that date despatches were forwarded both to India and to the Colonies, inviting their co-operation, and laying down the principles which the Royal Commission, after careful consideration, decided should be observed for carrying this Exhibition into effect.

These principles differed in some important respects from those which it is usual to adopt in the organisation of International Exhibitions, and I will briefly point out a few of the more striking deviations from precedents, and will endeavour to explain the reasons which guided the Royal Commission in departing from them.

It has hitherto been the custom, in inviting the co-operation of foreign countries and home exhibitors, to inquire as to the amount of space which they are likely to require for their exhibits, and to be guided in a great measure by the answers received as to the amount of space required to be set apart.

In the present instance, however, owing to the previous existence of the Exhibition buildings, which were capable of but little expansion, and to the length of time which must have necessarily elapsed before definite answers could have been received from the Colonies, it was considered desirable that the Royal Commission should itself allot the space, and inform the various Governments of the amount that could be placed at their disposal.

It must be also remembered that the sole duty of the Royal Commission as regards allotments, was that of handing over the various sections of the Exhibition to the Colonial and Indian Governments, leaving the Governments almost absolute control to sub-allot, as they thought fit, the space granted to them.

In making these allotments of space, it may

be mentioned that the Royal Commission, besides carefully considering the relative importance of the various Colonies and the amount of space which it would be probable each would require, were guided, as far as possible, by geographical considerations.

It will be remembered, for instance, that the whole of the African Colonies were placed together in the Queen's-gate Annexe; that the whole of the Australian Colonies were situated in the central courts of the buildings; that the West Indies, British Honduras, and British Guiana were contiguous, the one to the other, as were also the Eastern possessions, such as Hong-Kong and the Straits Settlements. Cyprus and Malta had a building to themselves, and Ceylon was placed in the immediate neighbourhood of India.

In previous Exhibitions it has always been the custom to prepare a general classification, under which the objects which each intending exhibitor—whether British or foreign—wishes to display must, on his application for space, be comprised. In the present instance it was, however, considered advisable that this rule should be departed from, and that each Government should be called upon to prepare such a classification as seemed most suitable to its own requirements.

The Royal Commission felt that to adopt a general scheme of classification would inevitably lead to invidious comparisons being drawn between the various Colonies. It seemed, to the Royal Commission, that it would be very unfair to ask those colonies of more recent settlement to comply with the same qualifications which would be applicable to those in an older and more advanced stage of development, and that a classification suitable to the inhabitants of a colony whose manufactures and arts were in a matured condition, would be utterly out of keeping with those having perhaps a history of but a few years' growth.

Another important deviation from the practice hitherto invariably followed by Exhibitions, was the decision of the Royal Commission that no jury system should be adopted, nor any competitive system of awards offered. Similar reasons to those just stated led the Royal Commission to this determination, it being specially considered that the feelings of general harmony and goodwill which it was hoped a gathering of this nature would develop, should not be disturbed by the struggles of trade rivalries, or the ardour of commercial competition.

In place of the jury system, it was decided that a series of reports should be prepared on the more important products shown at the Exhibition; and the Royal Commission is extremely indebted to the Council of the Society of Arts for having undertaken the important duty of singling out the best authorities on the various products, and for generally supervising this work, which is now on the eve of publication.

I may here state that a commemorative medal and diploma was presented to each exhibitor who participated in the Exhibition. A reduced copy of the diploma appeared, some time since, in the Society of Arts *Journal*, and I have obtained, for your inspection this evening, Mr. Riley's original design, from which reproductions in chromolithography were executed by the Lady Students of the Chromo-Lithographic Art Studio.

Another leading principle of this Exhibition was to the effect that nothing was to be admitted as an exhibit which was not the produce either of the British Colonies or of India; nor was any exhibitor to be granted space who was not an inhabitant of the British Colonies or, who in the case of India, had not a residence or a *boná-fide* place of business in that country.

In the carrying out of this principle, the Royal Commission was naturally dependent upon the efforts of the various Executive Commissioners, and there is reason to believe that, in spite of the difficulty of strictly adhering to it, this condition was, in the main, scrupulously complied with.

With the exception of a few regulations which it was found necessary to draw up for the general interests of the Exhibition, the Executive Commissioners of the various colonial sections were given the fullest latitude with regard to the arrangements of their Courts. Not only were, practically, no restrictions imposed upon the character of the exhibits which could be sent for display, but the decorations and arrangements of the respective sections were entirely left to the taste and discretion of the Commissioners; indeed, with the exception that a certain amount of supervision was exercised by the Royal Commission for the control of the visitors and general maintenance, the jurisdiction of each Executive Commissioner over his section was absolute. It was, no doubt, owing to this policy that the various Courts of the Exhibition assumed such typical and artistic forms, and that so much variety was displayed both in arrangement and in interest.

The Exhibition opened under the most favourable auspices, her Majesty performing the ceremony amidst the most widely representative gathering of her subjects that has ever been brought together, and no one who was present on that occasion can have failed to have been impressed by the magnificence of the spectacle or the stateliness of the proceedings.

The universal interest which this Exhibition aroused was clearly evidenced, not only by the large number of persons who visited it, but also by the deep attention which was paid by them to everything that was shown therein, and it is worthy of special notice that in spite of the undoubted attractions of the gardens, the bands and the illuminations, the buildings were always well filled with people engaged in minutely examining the many varied objects which they contained.

The total number of visitors amounted to 5,550,745, a number largely in excess of those who had visited the previous Exhibitions of this series, and only less than the attendances at the great Exhibitions of 1851 and 1862, the former of which was visited by 6,039,195 persons, and the latter by 6,211,103.

It is a striking evidence of the interest of this Exhibition that such vast numbers of the public were attracted to buildings already well - known to them, and thereby shorn in some measure of the attractions of novelty. 1,216,183 visitors were admitted under schemes initiated by His Royal Highness the Prince of Wales, in order to enable artisans—both provincial and metropolitan—with their wives and families to visit the Exhibition. The orderly behaviour shown by this class of visitors was beyond praise, and their intelligent appreciation of the contents of the various sections is worthy of special remark.

It is not my purpose, however, to enlarge upon this subject, important and interesting as it is, nor shall I advert to the more popular aspects of the Exhibition, as they are still fresh in the minds of all, and no good purpose would be served by recurring to them this evening. I would rather dwell upon the leading features which the various sections presented, and strive to bring back to your memories those objects, the display of which was expressive of the leading characteristics of the various territories under British rule.

Commencing with the great Empire of India, which, with the exception of the space allotted to Ceylon, occupied the whole of the southern portion of the Exhibition, it will be remembered that the Main Avenue was entirely occupied by the art products of the various provinces. Nearly all these objects, which had been collected either by the Government of India or by the Royal Commission, were exposed for sale, and realised in the aggregate upwards of £24,000. The remaining portions of these magnificent collections were contributed by their Highnesses the Princes of India, to whose generosity and hearty co-operation the Indian Section owed some of its most attractive features.

It can scarcely be doubted that the display of so much that was beautiful and artistic must tend to give an impetus to the art industries of India, and that the wonderful specimens of wood and stone carving which the screens afforded, will result in this style of work being adopted for the internal and external decoration of public and private buildings—more especially when its relative cheapness is taken into consideration. As an instance of the effect which can be obtained by the judicious application of Indian wood-carving to internal decoration, I may mention the Durbar-hall of the Indian Palace. The whole of this wood work was executed in England by two natives who were brought over from India for the purpose.

The Imperial Economic Court of the Indian Section was considered especially important by the Government. In that department was displayed every product of commercial value in India, and it may be described as a compendium of the economic resources, the productive powers and the commerce of that Empire.

The exhaustive and valuable paper recently read before the Indian Section of this Society by Dr. George Watt, the officer in charge of this section, renders it unnecessary for me to dwell upon its contents at any length: but to adequately estimate the importance of these collections, it should be remembered that they represented the food products and resources of 252 millions of inhabitants, and that the important foreign trade of India enables it to rank as the fifth great commercial power of the world.

In connection also with this department, I would wish to call special attention to the very valuable series of conferences which, at the request of the Government of India, were held at the Exhibition for the purpose of examining certain of the commercial products shown in the Economic Court, the properties of which

were either insufficiently known, or which were deemed suitable for new purposes. Many gentlemen interested in the subject attended, and the various products were subjected to careful examination and analysis. The valuable results which arose from these conferences are embodied in a pamphlet published under the direction of the India Office. The conferences embraced discussions on the following subjects:—Fibres, silk and silk substitutes, drugs, gums and resins, minerals and ores, oils, oil seeds and perfumery, dyes and mordants, tobacco, timbers and tanning materials, and leather.

It will be readily remembered that this Court was rendered specially attractive by the collections of models of the various races of India, and by a series of shops, in which were placed specimens of foods and drugs.

In the North Court of the Indian Section were situated the stalls of private exhibitors, but the most important feature in this gallery was undoubtedly the exhaustive collection of Indian teas, coffees, and tobaccos. I shall abstain in this place from any remarks on the importance of these exhibits, as they will find a more appropriate place later on in my paper. The silk industry of India was fully illustrated by the interesting and varied collections, both of the raw product and the manufactured article. These collections, formed by Mr. Thomas Wardle, were placed in the gallery which surrounded the entrance hall of the Indian Palace. Models and other objects illustrative of the administration of India were placed in the East Arcade.

The Ceylon Section, rich in remembrances of Buddha, was commercially conspicuous by its fine collection of teas and coffees, its woods, and its precious stones. As a specimen of artistic wood carving, the magnificent porch through which this Court was approached, rivalled in design and execution many of the best screens in the neighbouring Indian Gallery.

The various Courts in the Australian Section presented many points of strong family likeness. New South Wales, Victoria, South Australia, and Queensland, vied with each other in displaying not only their wealth of products, but also the astonishing progress they have made in the arts of civilisation. Paintings and statuary, furniture and clothing, carriages and saddlery, and gold and silversmiths' work bore witness to the taste and energy which in so short a time have converted primitive settlements and log huts into prosperous communities and wealthy cities; and, perhaps, in no other portion of the Exhibition was the rapid growth of the British Empire more astonishingly illustrated than by the collections of these great Colonies.

The largest of the Australian Courts were occupied by New South Wales and Victoria. The former of these great Colonies will best be remembered by the magnificent display made by it of mineral wealth, comprising gold, silver, copper, zinc, tin and coals, on the importance of which collections the late Sir Alexander Stuart, the Executive Commissioner for the colony, laid special stress. Wool and grain were, naturally, largely represented, New South Wales being pre-eminently an agricultural and pastoral colony.

Victoria will be chiefly remembered by its gold and wine trophies; by its furniture and wall decoration, and especially by its collection of paintings. With the exception of Canada, and perhaps New Zealand, the fine arts seem to have made greater progress in this colony than in any other.

A special feature was made in this section, as well as in that of New South Wales, of photographs of towns and scenery. Not only were these photographs of great artistic excellence, but they contributed not a little to the general impression which the visitor received of the wealth and prosperity they indicated.

The arrangement of the South Australian Court was specially attractive and instructive. Visitors will remember that on entering it from the north-east, they were confronted by a life-like presentment of the seashore, and that, on the supposition that they were gradually progressing inland, the River Murray was reached, on the banks of which appeared a most realistic representation of an aboriginal encampment. Beyond this scene, a log-hut was erected as indicative of the first intrusion of the white man into the interior of the country. Then, in natural sequence, were displayed sheep in their pens, goats, and lastly, the camels used for purposes of exploration. On the opposite side of the Court were ranged cases of wool, and of the cloth manufactured therefrom, trophies of mineral wealth, and specimens of manufactured articles. At the extreme end of this section were shown the various wines of the colony, an industry which may be considered as the last outcome of its enterprise.

The arrangements of the Queensland Court were admirably contrived, and on more than

one occasion elicited the hearty approval of many of the Executive Commissioners. Woods, wools and minerals, ranged in the most systematic and instructive manner, were its most prominent exhibits, and the visitor was reminded of the tropical character of the colony by the magnificent collections of birds and plants which adorned the Court.

A notable feature of the Queensland Section was the gold-extracting machine which the Government were enterprising enough to send over from the colony, together with a sufficient amount of ore to keep it in working order during the whole time of the Exhibition.

Intimately connected with the Queensland Court, and under the direction of its Executive Commissioner, was formed an interesting collection, illustrative of the aboriginal life and the natural history of New Guinea. It may be noted that this Court was remarkable as affording no evidence of the advent of civilisation.

Western Australia, the largest of the divisions of this great continent in point of size, but, as yet, less populated and developed than any of the others, offered to visitors lessons as instructive and suggestive as could be gained in any other section of the Exhibition. The marvellous trophies of jarrah, karri, and other woods, the pearl shells, minerals, and natural history collections, gave abundant evidence of the great future which this colony has in store, and of resources which merely require a larger population and more extended enterprise to cause Western Australia to take her place on equal terms with her sister states.

The New Zealand Section will be specially remembered for its collection of Maori relics, and also for the natural history specimens lent by the Canterbury Museum. But this colony was not less represented than those of its neighbours in Australia, by the evidences which it displayed of agricultural, pastoral, and mineral wealth; by its pictures, its beautifully designed and executed specimens of furniture, and by its manufactured articles.

Adjacent to the New Zealand Court was situated a conservatory filled with the tree-ferns and other plants for which this colony is so justly celebrated. And it may here be mentioned that several other Australasian colonies contributed to the charms of the Exhibition by conservatories, filled with indigenous plants.

The little Court devoted to Fiji completes our survey of the Australasian group. Though fallen amidst evil times in consequence of its staple trade (sugar) being in so depressed a condition, samples of the various other products it can produce bore evidence of the fertility of its soil and the geniality of its climate.

I will next proceed to call to remembrance the contents of the Queen's gate Annexe, in which were situated the Courts of all the British possessions on the continent of Africa.

Undoubtedly the greatest attraction in the Cape of Good Hope Section were the exhibits connected with the great diamond industry, the importance and development of which may be gathered by the fact that in 1868 the declared value of diamonds exported was £150, whereas in 1886 it reached the sum of £3,507,210.

Here, as in Queensland, a machine was erected to show the method of extracting mineral wealth from the soil. A large quantity of the celebrated blue ground from the Kimberley district was contributed by three different companies, and was daily treated in the same manner as it would have been in the district itself; and the same proportion of diamonds was there extracted from it as is usually the case in the colony. In addition to the extraction of diamonds from the soil, practical demonstrations were given of the method of cutting and polishing the stones by electrical machinery.

Beyond this exhibit was shown a model of the Bultfontein diamond mine in Griqualand West, and at the side were ranged cases containing magnificent specimens of rough diamonds.

The ostrich feather industry was also largely represented in this Court, and the processes of cleaning and dyeing the feathers were practically shown.

The remainder of the Cape Court was devoted to exhibits of furniture, specially interesting in that they were executed by Kaffirs, under English supervision; minerals, woods, wool, and game trophies were also prominent. In a conservatory adjacent to the Court were displayed indigenous plants and shrubs.

The exhibits in the Natal Court naturally resembled in a great measure those of the Cape. Special attention should be drawn to the specimens of teas which were shown in this Section, as being an entirely new industry, and one likely to develop to a great extent, owing to the suitability of the climate for the growth of this plant. The walls of the Natal Section were adorned with trophies of Zulu

weapons, and a conservatory ornamented the north end of the Court.

The West African colonies occupied the rest of this building, and included collections from Sierra Leone, Gambia, the Gold Coast, and Lagos. These collections comprised the fetishes, implements and apparel of the natives; and the forms of ornamentation displayed upon the cloths, bowls and other objects were often indicative of a higher state of feeling for art than might have been anticipated from a race which is otherwise so little advanced in civilisation. The collection of gold ornaments from Ashantee, by which the indemnity was paid after the war with that country, was especially noticeable, and many of the tokens were of beautiful design and workmanship. Besides these collections of ethnographical rather than commercial interest, samples of the articles of commerce of these important settlements were exhibited, the principal among which were palm oil, rubber, fibre, and gums.

Crossing in imagination both the Atlantic and the Exhibition, I will now call to your remembrance the West Indian collections. It was a happy circumstance that it was found possible to combine the many Colonies comprised in this large and important group of islands under one roof and management, the result being that visitors obtained a far juster estimation of their commercial importance than has ever hitherto been possible.

Besides being one of the great sugar-producing countries, the West Indies could bear evidence to their wealth in timber, in minerals, in fruits, and in the produce of the sea, such as pearls, coral, shells, and sponges. The centre of the West Indian Section will long be remembered for the beautiful collection of pictures, and for the relics both of prehistoric eras and of the early settlers.

It is well known that the trade of the West Indies is at present, unfortunately, in a far from flourishing condition; but it is to be hoped that the striking displays of their sources of wealth, both actual and possible, may lead to the advent of better times. It surely cannot be that islands so favoured by nature can long fail to win for their inhabitants the prosperity which they at one time enjoyed.

Within the jurisdiction of the Executive Commissioner for the West Indies was situated the Court of British Honduras, chiefly noticeable for its fine collections of mahogany and other timbers.

Next to the West Indian Section was placed the Colony of British Guiana,—closely allied to the West Indies by its situation and products. Here, again, sugar is the staple trade; but that it has other resources was abundantly proved by the magnificent trophies of timber which adorned each end of the court. Special interest was given to this court by its valuable ethnographical collections.

Beyond British Guiana were situated the sections of the Straits Settlements, Hong-Kong, and British North Borneo.

The Straits Settlements, besides sending a large collection of models of houses and boats, and also the regalia from Perak, contributed a most interesting collection of food products and drugs. The Malay House, erected by native workmen in the gardens by this Commission, will be remembered by all.

British North Borneo was chiefly remarkable for the fine collection of timbers, in which this colony abounds. Samples of pearls and of newly-discovered gold were also shown.

The Hong-Kong Section was appropriately placed in the court which had been occupied, at previous Exhibitions by China. The great wealth of this dependency was made strikingly apparent by models of docks and manufactories, and by a large display of samples of the various products in which it trades.

In the Eastern Arcade were situated the Mauritius and Seychelles Courts, containing samples of sugar, vanilla, and hemp; the isolated settlements of St. Helena, Ascension, and Tristan d'Acunha, the former of which islands contributed many interesting relics of Napoleon the First; and a small case, containing wool and the other products of the Falkland Islands.

In the East Annexe were placed the collections from two of our Mediterranean possessions—Malta and Cyprus. The former will be best remembered by its attractive collections of lace, silver-work, stone-carving, and tobaccos; the latter, by most interesting examples of native agricultural implements and contrivances. Cyprus also displayed samples of its wines—an industry which is rapidly growing in importance.

To the Dominion of Canada was originally allotted the whole of the central and half the west galleries, but it soon became apparent that this space would be entirely inadequate for the large number of Canadians who desired to participate in the Exhibition. Little by little did the Executive Commissioner ask and obtain from the Royal Commission the spaces which had been fortunately held

in reserve to meet possible eventualities. Gradually did he obtain the whole of the east and west quadrants, and the gallery in the conservatory; but even these additional spaces were not sufficient for the demands which were being made upon the Canadian Commission. Extra buildings were erected on spaces in the South Promenade and elsewhere, and it eventually became necessary to obtain leave from the Government to occupy part of the museum galleries which fortunately happened at that time to be unused.

The display made by the Dominion forms a worthy close to the brief survey which I have just been taking of the various sections of the late Exhibition.

Few that visited the Exhibition will forget the beautiful and characteristic trophy of agricultural produce gathered from all the provinces of the Dominion which adorned the Eastern Transept of the Central Gallery, or the hunting trophy at the other end of this Court. A large space in the West Gallery was devoted to educational exhibits, a magnificent collection of minerals filled the corridor between the West and Central Courts, while the fine arts were well represented in the galleries of the Royal Albert-hall.

The Canadian Courts differed to a large extent from those of the other Colonies. It was essentially a section of private exhibitors, and hence the resemblance which it bore to Exhibitions we have hitherto been accustomed to witness was far closer than the other displays in the buildings.

Moreover, although the collections of raw produce were as notable in this section as in any of the others, they were largely outnumbered by those of manufactured articles. The reason of this difference is not far to seek. Canada is, comparatively speaking, close to us, and in sending to us specimens of her manufactures, she did so with the determination of increasing or creating a trade for them in Europe.

While the Colonies in Australasia and Africa were content with sending a sufficient number of specimens of their manufactures for the purpose of showing how far they were advanced in the arts of civilisation rather than of creating a direct trade in these articles, the position of Canada enabled her to take advantage of this Exhibition in order that she might successfully compete with the manufacturers of the United States for the supply of articles for European use. Nor has she, I think, any reason to be disappointed in her efforts in this direction. The Canadian exhibitors have frequently expressed their entire satisfaction at the results which they have achieved. Scarcely a single machine in the agricultural implement gallery, or piano or piece of furniture in the Central Court, remained unsold at the close of the Exhibition, and I am informed that many exhibitors have received sufficient orders to keep them at work for many months to come.

Nor must the other results of Canada's participation in the Exhibition be lost sight of. She, with the single exception of Western Australia, is the only colony which at the present time encourages immigration. With a population equal to that of London and with an area thirty times as large as Great Britain and Ireland, by far the greater portion of which is capable of supporting settlers, with unrivalled means of communication both by land and by water, she affords an opportunity to the intending emigrant to settle in British territory under conditions most favourable to his future prosperity and well-being.

I will now venture to detain you for a few moments with considerations upon certain of the more important articles of commerce which we have lately been in imagination inspecting, and I would especially wish to refer to those products the trade in which this Exhibition may surely lay claim to have stimulated, and even in some cases to have created; and here I would desire to express my obligations for having been permitted to peruse the advance sheets of the official Reports upon Products, which I have already referred to as being on the eve of publication, under the auspices of this Society. Almost all the remarks of any value which I am about to make are drawn from these sources.

The mineral wealth of the Colonies is already well known. Australia has long been recognised as one of the great gold-producing countries of the world, and the magnificent displays made by her five sister States of gold and of the baser metals rather confirmed the knowledge we previously possessed than revealed to us any new sources of wealth. The three huge gilt monoliths erected in the New Zealand Court, figurative of the total output of gold by this colony, demonstrates that these outlying portions of the Australian Continent can claim their share of this precious metal. Canada's contribution of mineral products was of great importance and completeness; indeed, Mr.

J. R. Gregory, the official reporter upon minerals, refers to the Dominion collections as being for variety, as well as for interest and rarity, unrivalled by that of any other colony. I have already made reference to the great and growing importance of the diamond industry of the Cape of Good Hope.

I will next refer to the imposing collections of timbers, in the display of which scarcely any section was unrepresented, and which, especially in the case of India, Canada, Western Australia, Queensland, New Zealand, British Guiana, and Honduras and North Borneo comprised specimens of astonishing variety and beauty. There is, doubtless, a vast trade in woods to be developed with our Colonies, for it cannot be imagined that the attention they deservedly attracted at the Exhibition will be allowed to wane. The experiments made by Mr. Ransome on many of the samples which were shown, the results of which were described by him before the last meeting of this Section, will also doubtless tend to give an impetus to the introduction of a larger number of Colonial woods into our workshops.

Turning to the pastoral and agricultural industries, experts were struck with the very great advance made, not only in the quality and quantity of the wools shown by the Colonies, but also by the improvements which they have, with the aid of scientific agriculture, effected in the character of the sheep. Dr. Bowman, the writer of the official report upon wool, from which I have gathered this information, states, moreover, that, with few exceptions, all the exhibits were so good, that they might be said to indicate the high-water mark of our present possibility in sheep culture, that probably no display of wool ever equalled it, and that a feeling of astonishment was created that such results could have been attained within the comparatively short period since the foundation of many of the Colonies.

It has been more than once asserted of late, upon good authority, that we may, within the limits of the British Empire, obtain such addition to the home supplies as to be entirely free from reliance on foreign sources of food; and the remarkable richness of the Exhibition in collections of food products must have impressed every visitor with the vastness of our agricultural wealth. In India, Canada, Australasia, and South Africa, we possess granaries of enormous extent and yearly development, and the cereal displays made at the Exhibition in the sections of these countries supplied abundant proof—if proof were needed—of our independence of foreign markets for the supply of bread.

Though New Zealand was the only colony which gave a continuous display of frozen meat in the Exhibition, it is well known that the other great Australian Colonies are large exporters of this product, and the importance of Australia as a source of food supplies is well shown by the fact that New South Wales alone possesses more sheep than the United Kingdom, while Queensland has three-fourths as many cattle. The comparative proximity of Canada enables her to export live stock to this country, and it is to be regretted that her Government were unable to carry out their intention of holding in London a show of sheep and cattle concurrently with the Exhibition. The tinned meat industry was well represented both in the Canadian and Australasian Sections. Canada, especially through her provinces of Quebec and Ontario, made a magnificent and varied display of dairy produce, and fresh consignments were constantly being received throughout the course of the Exhibition.

The Exhibition market, wherein Colonial food products found a ready sale to visitors, will be specially remembered from the consignments of fruit and vegetables with which it was regularly supplied. These consignments were entirely experimental in character, and the success which they achieved cannot fail to create a permanent and rapidly increasing trade. Victoria, New South Wales, South Australia, Queensland, Natal, and the West Indies, were the principal contributors to this section, nor must the magnificent collection of Canadian apples and honey be forgotten.

The rising and important wine industry o Australia merits special attention. In spite of adverse criticism from certain quarters, the Royal Commission is convinced that the arrangements it made for the administration of this department were adequate, and that every possible facility was afforded for the display and sampling of the wines sent over. It may not be without interest to state that the whole of the wines forwarded to the Exhibition were disposed of before its close, and that upwards of 350,000 glasses were consumed by visitors desirous of making themselves acquainted with these wines. It is also a fact worthy of mention that the import of Australian wines to this country, during the year 1886, shows an increase on the previous year of over 233 per cent. The wine exhibits

of the Cape, Cyprus, and Canada, and the liqueurs from the West Indies, found also a ready sale at the Exhibition.

The development of the Indian tea industry forms a striking example of successful enterprise. Founded but a quarter of a century ago, this industry has developed to such a rapid extent, that it now competes with China in the London markets on equal terms. Indeed, whereas the imports of China teas for consumption in this country amounted, in January, to 6,500,000 lbs., those for India and Ceylon amounted to 8,000,000 lbs., showing a balance in favour of India of 1,500,000 lbs. It should perhaps be mentioned that the tea sold to the public in this country consists, for the most part, of a Chinese and Indian blend, the acknowledged superiority of the latter product giving strength and character to the former.

The successful introduction of tea plantations in Ceylon is rapidly restoring to that island the prosperity which it had, in a great measure, lost owing to the failure of the larger portion of its coffee crops. Fiji and Jamaica are also making experiments in the same direction, while Natal is proving that, in South Africa, tea may be cultivated under favourable conditions.

Though British possessions contribute less than one-tenth of the total production of coffee in the world, the quality of Indian, Ceylon, and Jamaica coffee is firmly established above that of all other kinds, and numerous samples from these possessions were shown at the Exhibition. Besides Jamaica, many other of the West Indian islands, British Guiana and Honduras, sent coffee exhibits, as also did Natal, Queensland, Fiji, and Mauritius.

Both the tea and coffee exhibits were placed by the Royal Commission under the able and impartial management of Messrs. Henry S. King and Company, who not only arranged the various samples for exhibition, but also sold these products, both dry and infused, to visitors. Messrs. King were assisted by committees appointed to represent the interests of the exhibitors, and who superintended the purchase of suitable teas and coffees, and gave a guarantee of their purity.

The cocoa exhibits (chiefly from the West Indies and Ceylon), and the tobaccos from India, Jamaica, and Malta, were also under the superintendence of Messrs. King. The Cape and Canada also contributed samples of this latter product.

With the greater and wider results which it is sincerely to be hoped may grow out of the late Exhibition I scarcely feel competent to deal. But I would venture, in conclusion, to revert to one consideration which can hardly fail to have impressed each thoughtful visitor, after a study of the great map which was prominently emblazoned upon one of the walls of Exhibition, and that is the almost absurd disproportion which the size of Great Britain bears to her possessions. Indeed, the United Kingdom occupies a space of less than one-sixtieth part of her Empire. It is, indeed, true that this disproportion at present holds good merely as regards geography, that in population (with the exception of India) in wealth, in trade, and in commerce, the United Kingdom largely exceeds in importance its dependencies; but that this will always be the case is extremely doubtful. In ten years Canada has increased her population by 17 per cent. Victoria, which only began its existence as a colony in 1851, now supports a population of upwards of 1,000,000 souls, and its capital, Melbourne, which fifty years ago consisted of a few log huts, at present numbers a population of 322,690, and takes its rank as the twelfth city of the Empire. It is needless to multiply evidences of this rapid development of our Colonies, which was to be witnessed at the Exhibition on all sides, and which forces us to the conclusion that, ere long, the position of England and her dependencies will undergo a great change in their relative importance.

With these facts in mind, and with the high object of securing the permanent existence of the British Realm, it is surely imperative that no effort should be relaxed to perpetuate the intimate relations which now happily exist by community of blood, of language, and of interest, and to encourage in every possible manner the already large trade which is carried on between the Mother Country and her children.

It has been well said that the greatness of this country lies in the future rather than in the past or present. The justness of this remark is surely confirmed by the lessons which the Colonial and Indian Exhibition has been the means of teaching to us.

DISCUSSION.

Mr. E. L. Beckwith said he believed it was the custom in opening the discussion to criticise the paper, but he confessed he was unable to offer any hostile criticism. The paper recalled to his mind in a very clear

way one of the most interesting Exhibitions which had ever been held, and if nothing else resulted from it beyond giving pleasure to the toiling millions of the country, it would have done a vast deal of good. England was a hard-working country, and he thought they ought to be very grateful to the Prince of Wales and those who worked under him for having been the means of giving them such an Exhibition. No one could have failed to be struck by the artistic workmanship displayed by some of the natives, and he thought it was quite time that technical instruction should be given in English schools, in order to enable English workmen to hold their own. The Exhibition had proved that England and her Colonies produced everything which a man could possibly want. The reader of the paper had said it was very astounding, in looking at the map, to see how small a portion England occupied with her great Colonies; but he looked upon England as the heart of the world, as from it flowed all that civilised and humanised mankind, and in return received the products of her labour. So long as England continued to share with other places the bounties which nature had given her, she would continue to occupy the proud position in which she now stood.

Mr. W. H. Preece, F.R.S., said the matter had been so fully brought forward by the reader of the paper, that there was little left to be said. He was one of those who felt that, in the ensuing summer, there would be a blank in one's existence. For the last four or five years London had been benefited by Exhibitions of increasing grandeur and interest, that they could scarcely yet realise the fact that the Exhibitions had ceased. In the last Exhibition there was something to interest every class and age; not only did it show to the grown up portion of the public the produce of other countries, but it enabled them to teach the children real and true geography, and to explain the enormous resources of the Empire. The one main feature of the success of the last Exhibition had not been touched upon, and that was the extensive use of the electric light. Nothing had succeeded so much in bringing into prominence, and showing the practical advantage of the electric light, as these Exhibitions. It was true that in the earlier exhibitions, failures in the electric light had to be recorded, but such was not the case with the Colonial Exhibition, which had proved to demonstration that the light could be economically employed. The lesson thus learnt had been taken advantage of, for during last year the electric light, for the purpose of illuminating fountains, had been adopted in America. The *furore* for Exhibitions had not ceased, for in the present year Exhibitions were to be held at Liverpool, Newcastle, and Manchester, and at the latter place, the lesson taught at South Kensington would be taken advantage of, for the plan was to be adopted in its entirety. Exhibitions were also spoken of at Adelaide and Melbourne, and before many years he had no doubt that every colony which was represented at South Kensington would copy the example which had been set them. He trusted that as the Colonial Exhibition succeeded in attracting so many thousands of people from the Colonies, that these Exhibitions would induce those who could afford it, to go abroad and visit them, and thus see how the children of England were flourishing in their new homes.

Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., considered it refreshing to hear from Mr. Preece that the Colonies were copying what had been done at South Kensington. As time went on, some little credit might be given to the past, although he thought they were too near the close of the last Exhibition for justice to be done to those who made it. The persons who had really made the Exhibition were the Executive Commissioners, and, in his opinion, no more able or distinguished men could have been found. If that Exhibition had been distinguished among all past Exhibitions, as he claimed it had been, it was because it was marked by that individuality which was displayed by the various Executive Commissioners in the arrangements they made, for which, as yet, they had not been sufficiently thanked. It was very gratifying to see that the Exhibitions now springing up were being carried out on the same lines as that lately held at South Kensington, and he believed that the lessons there taught would long last to the aggrandisement of the Empire.

Mr. J. G. Colmer bore testimony to the able manner in which Mr. Edward Cunliffe-Owen, as Assistant-Secretary of the Commission, had performed his duties. The organisation of the Exhibition and the various details had been so thoroughly dealt with in the paper that there was little left to be said, but he might perhaps be permitted to say that, in his opinion, one great result of the Exhibition had been to strengthen the bonds of union which bound together the Mother Country and the Colonies. Few of the colonists would forget the hearty welcome which they received, or the great hospitality extended to them wherever they went. The idea of the Exhibition must be regarded as having been most happy and opportune on the part of the Prince of Wales, the president of the Society of Arts, and showed clearly the interest his Royal Highness took in the Colonies and their development. It was not a matter of surprise to him that the idea of the Exhibition had been taken up with alacrity by the Colonies, because it gave them an opportunity of showing the great advances which they had made. Speaking for the Dominion of Canada, he might say that the matter was taken up from the first with very great enthusiasm; indeed, the only difficulty was to obtain space for the exhibits offered, and at the last moment they had to refuse one or two cargoes of exhibits on this account. The exhibitors were, he believed, satisfied with the result financially and otherwise, as most of the exhibits for sale had been sold,

and many Canadian houses had opened branches in this country in order to continue the business inaugurated by means of the Exhibition. He did not think that the results, great as they had been, should be allowed to drop; the seed had been sown, and an interest awakened in the Colonies, and he trusted the seed would be nourished and cultivated in order that greater advantage might arise both to the Mother Country and the Colonies. The development which such questions as federation, emigration, employment of capital in the Colonies, and the extension of commerce had lately undergone, was greatly owing to the Colonial and Indian Exhibition, and he regretted that Sir Charles Tupper, who was in Canada, could not have been present that evening to express his thanks to Sir Philip Cunliffe-Owen, and those who worked under him, for what they had done in promoting and carrying out the Exhibition.

Mr. HARRIS (Commissioner for the Bahamas) also bore testimony to the attention which Sir Philip Cunliffe-Owen had invariably given to all who were in any way connected with the Colonies. He agreed with the last speaker that it was not only the commercial advantage which the Colonies would derive from the Exhibition, but it was also the kindly feeling created between the Colonies and the Mother Country that this undertaking had encouraged. A short time ago but little attention was paid to the Colonies, though he was glad to say that was not now the case. He regretted exceedingly that the Exhibition would not be continued for another year, as exhibitors had spent large sums in bringing over the produce of the Colonies, and had it not been for the clamour of a few persons he did not believe the Exhibition would have been closed, and thus great loss to the Colonies would have been avoided. With regard to the accusation which had been made by some people that the Exhibition bore a resemblance to Cremorne, he thought that a more unfounded and disgraceful charge had never been made. He should have been glad if an official had been deputed to go round the Exhibition with Colonial visitors, and point out to them some of the more interesting exhibits. Speaking of the Imperial Institute, he deprecated the notion of a museum being held in the City, believing that it would be an utter failure, and that South Kensington was the most fitting home for such an Institute.

The CHAIRMAN, in proposing a vote of thanks to Mr. Edward Cunliffe-Owen, said they must all be grateful to the Prince of Wales for having originated the idea of an Indian and Colonial Exhibition, and for having lent his aid in carrying it out to a successful issue; but still they must not forget that the success of the Exhibition was mainly due to the admirable organising power and ability of Sir Philip Cunliffe-Owen, aided by the reader of the paper and the staff under him. He had had an opportunity, like every other Executive Commissioner connected with the Exhibition, of coming into daily contact with Mr. Edward Cunliffe-Owen, therefore he was in a position to say that this gentleman had most zealously performed the important duties appertaining to his office. Indeed, he often pitied him when he saw how many people went to him upon useless questions. He felt sure that every one who had visited the Exhibition would admit that it conveyed instruction with regard to the Colonies which no other means could well have afforded. One of the speakers had referred to the fact that visitors wished an officer could have gone round the courts and pointed out objects of interest, but he had seen on several occasions schoolmasters and schoolmistresses going round the building calling attention to matters of interest, and this he considered was a great means of instruction. There was a great want of knowledge with regard to the Colonies. Colonials were as English as those who resided in this country. The last Exhibition had brought to this country something like 10,000 visitors from the Colonies, and if each only spent £200, the tradespeople of England had gained over £2,000,000 of money. This showed that the Exhibition had been of immense advantage to the people of this country. In complying with the previous speaker, he regretted that the Exhibition had not been continued for another year, the more especially as the primary cost had been incurred.

The vote of thanks having been carried unanimously,

Mr. EDWARD CUNLIFFE-OWEN, in acknowledging the vote, said, had time permitted, there were many subjects which he might have touched upon in the paper, such, for instance, as the steps taken to form a guarantee fund, and the extraordinary response to the appeal. The success of the Exhibition, from a financial point of view, had been undoubted, and from the report which would shortly be issued, it would be seen that there was a substantial surplus. He had purposely omitted all reference to the electric light in his paper, as he knew that Mr. Preece would be present, and could explain much better than he could the admirable way in which the light had been worked. He agreed that there had not been a single case of break down of a serious kind during the last Exhibition. The establishment of the emigration-office at the Exhibition had done a great deal of good, as had also the literature which had been published, and the important conferences which had taken place.

TWELFTH ORDINARY MEETING.

Wednesday, March 2nd, 1887; Sir EDWARD BIRKBECK, Bart., M.P., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Eves, C. Washington, 1, Fen-court, E.C.

Frank, Julius Charles, 3, Newman's-court, Cornhill, E.C.

Nash, Isidor, 25, Whitechapel-road, E.

Parker, John, Nelson-villa, Hereford.

Travers, William, M.D., F.R.C.S., 2, Phillimore-gardens, W.

Unwin, John, Southport, Lancashire.

The following candidates were balloted for and duly elected members of the Society.

Bennett, James, Ruchill, Glasgow.

Grove, W. B., B.A., Queen's College, Birmingham.

Leane, George Henry, 21, Queen Anne's-gate, Westminster, S.W.

McIntosh, James, Duneevan, Oatlands-park, Weybridge, Surrey.

Marwood, David, School of Art, Halford-house, Richmond, Surrey.

Simpson, A., B.A., Constitutional Club, W.C.

Webb, Francis William, Chester-place, Crewe.

The CHAIRMAN, in introducing Mr. Beale, said this subject was one of the greatest interest to the British farmer, especially at the present time, and if the results of the experiments made during the last and present season should prove that tobacco culture could be carried on at a profit in England, the agriculturists would be grateful to gentlemen like Mr. Beale, who had taken such a prominent part in these experimental trials. The subject was not new to the public, who had already learned, through the Press, what had taken place since March last, when the matter was first brought before the country. On the 8th March, he asked the then Chancellor of the Exchequer whether he would, under certain conditions, allow tobacco to be grown in the United Kingdom; and during the next fortnight negotiations took place between the Government and Lord Harris, and himself, which resulted in permission for experimental trials in the United Kingdom being given under certain conditions, viz., that any gentleman who desired to make experiments might do so, provided he found sureties in the sum of £100 per acre. The result of those experiments would be brought forward to-night, and he did not think there was anyone in England better able to bring this subject to the notice of the public than Mr. Beale.

The paper read was—

THE CULTIVATION OF TOBACCO IN ENGLAND.

By E. J. BEALE.

The condition of British agriculture has reached such a critical stage, that no apology is needed to introduce to the notice of the farmer any new form of cultivation that may be thought to have a reasonable chance of success.

This being conceded, I feel justified in stating that last season's experiments in the cultivation of tobacco, in England and Ireland, resulted in a success satisfactory beyond the hopes of the most sanguine promoters of the experiments, and whilst I would most particularly desire to recommend the exercise of reasonable caution in the matter of area or extent of future experiments, I feel that those results have more than justified further trials.

With historical precedents for its forcible exclusion, and with these prohibitions but imperfectly understood, it is not surprising that a certain amount of doubt and discouragement should have found expression; but I cannot agree with the opinion frequently expressed, that any great difficulty is to be feared in the thorough exercise of the revenue regulations; and I venture to repeat here a simple form of license that I have already suggested to her Majesty's Government. I believe a license something in the way of my plan would meet all the requirements of the Board of Inland Revenue, and would, moreover, present the subject to the eye of the British farmer in a far more popular form than is obtained by the cumbersome system of sureties at present demanded by the authorities before the cultivation of a tobacco crop is sanctioned.

This form (p. 385) to be obtainable, for a fee of one shilling, by any one desirous of cultivating a larger area of tobacco than the law allows to be grown free of duty. Such a license would be in duplicate; the one retained by the authorities. The Government will then have at their finger-ends a complete list that can be readily divided out and placed in the hands of the various Excise officers in the country, whilst the penalties already existing under statute, promptly enforced from any one cultivating an acreage tobacco crop without being in possession of this license, would very soon make things uncomfortable all round.

The origin of the movement for promoting English tobacco cultivation commenced with some remarks made by Mr. de Laune at an agricultural meeting when reviewing the existing depression of the farming interests, and the subject was brought prominently into notice on the 29th of March (1886) by Lord Harris—a neighbour of Mr. de Laune—

LICENSE TO GROW TOBACCO UNDER EXCISE REGULATIONS.

Full Name and Address of Cultivator.	Name of Parish in which Crop is to be grown.	Name and Address of Owner of Land where Crop is to be grown.	Name and Address of Tenant of the Land on which Crop is to be grown.	Name by which Field is identified by the Occupier.	Acreage intended to be grown.	Variety intended to be grown.

in a practical and powerful speech in the House of Lords; and although their lordships did not arrive at any determination, it was generally admitted that the importance of the question justified the fullest inquiry, and hopes were freely expressed by both branches of the Legislature that experiments might be made with a view to determine whether tobacco could be depended upon as a farm crop in Great Britain; and if so, whether it could be cultivated to give a reasonable profit to the producer? As the result of a discussion in the Lower House, the Government suggested that the Council of the Royal Agricultural Society should lend its powerful aid in assisting the experiments, and at a meeting of the Council on the 6th of April, under the presidency of His Royal Highness the Prince of Wales, the subject of tobacco-growing was discussed at considerable length; but no practical action was taken by the society—on the contrary, an opinion was expressed that the season was too far advanced to hope for any chance of success, and, so far as the Royal Agricultural Society's interest extended at that time, the matter lapsed. The severe restrictions considered necessary by the Board of Inland Revenue doubtless also induced many who were disposed to encourage and assist the experiment, to give up the idea.

In the meantime, recognising the necessity for prompt action if the season was to be saved, the firm I am connected with (Messrs. Carter) cabled to America, and from the most reliable sources obtained seeds of those varieties of tobacco that, from the locality of their introduction, were considered best adapted to the English climate. At this early period Messrs. Carter had determined to make an experiment in the growth of tobacco as a farmer's crop at their own expense, the intention being at that time to establish the fact whether tobacco could or could not be successfully grown in this country, and bearing in mind the prohibitory Excise conditions, to destroy the tobacco upon the ground after the question of the possibility of successfully growing the crop had been fully established.

Several noblemen, landowners, and agriculturists also obtained plants or seeds, amongst others Lord Walsingham in Norfolk, Mr. Faunce de Laune in Kent, our chairman, Sir Edward Birkbeck, in East Norfolk, and Mr. Bateman in Essex, and the crops grown upon the estates of these gentlemen, with that of Messrs. Carter, formed the principal acreage experiments of the year, although less important experiments were made in Berkshire, Devon, Worcestershire, Westmoreland, &c.

Lord Walsingham's crop consisted of the "Pennsylvania," "Big Frederick," "Virginia," and Connecticut" (the three first-named being varieties of a high standard of excellence), and was planted in a somewhat exposed situation, having an eastern aspect, yet the results, so far as the growth of the crop was concerned, are reported as being most satisfactory; and sanguine hopes may reasonably be entertained as to the ultimate success of his lordship's experiments, which can only be fully determined after the tobacco has passed into the hands of the manufacturer.

Mr. Bateman's crop in Essex, and Mr. de Laune's acreage in Kent were marvellous examples of what high farming, with the advantage of favourable surroundings, will accomplish, and it is to be regretted that by an unfortunate accident the value of Mr. Bateman's experiment was lost, the tobacco being destroyed by fire during the process of curing.

Though the season was late for making the experiments, Sir Edward determined to plant

two plots of land at Horstead with the following varieties of tobacco:—*Nicotiana rustica* (Turkish), *N. Texana*, *N. Syriaca*, *N. Libani*, *N. Attenuata*, and *N. Virginica*. One plot was situated in the kitchen garden alongside a bed of asparagus, another plot at the end of an open and exposed field on which barley was growing.

There had been no special cultivation of either plot for this particular plant, which had to take its chance in the kitchen garden with the vegetables for culinary use, and in the field with the barley crop. But it may be inferred that the land in each case was in "good heart," though not in such excellent condition as is considered by many necessary for tobacco cultivation.

The seeds were sown in a hotbed, where they grew rapidly, and then pricked out in shallow wooden boxes, to be kept for a time in a lower temperature. It was not till the middle of June, because of the cold nights, which would be fatal to them, that the plants could be set out in the open ground.

At maturity the Turkish and Syriaca were not equal in size of leaf or quality to either the Texana, attenuata, or Virginica, in fact, were evidently not adapted to the climate. The Texana was fair tobacco, but not equal to the attenuata or Virginica, both of which varieties were good, the Virginica especially having very large leaves, many of which would have had more body had the plants been topped sooner. The growth of the two last-named varieties must convince even the most prejudiced that tabacco can be grown, and profitably so, in the Eastern Counties; that, together with the fact of tobacco having been grown in Scotland, ought to remove all existing doubts as to its successful cultivation throughout the British Isles.

Mr. de Laune's crop was grown under conditions of an exceptionally favourable nature for the development of the plant, the tobacco being planted in small sections, these in their turn margined with hops. Unquestionably, the protection afforded by the hops tended to concentrate and retain the sun heat, with the result that the plants reached an enormous size, prodigious leaves being produced that would astonish cultivators in many other countries; but, at the same time, it is questionable whether these conditions of cultivation were desirable.

An opinion has been expressed that these circumstances were not the most acceptable, inasmuch as whilst Messrs. Carters' plants, exposed more or less to the action of the air and wind on all sides, and planted very wide apart, were fast ripening when the crop was harvested, Mr. de Laune's plants—put into the ground at the same time—had the appearance of being still in growth, or, at any rate (except in the case of "Kentucky"—an unusually early kind), the leaves were quite green and full of sap when seen upon the land some days after the whole of Messrs. Carters' crop had been housed.

A recent Government inquiry into the growth of tobacco in the United States shows that, while the tobacco plant exhibits a great facility in adapting itself to various soils and climates, its cultivation is practically restricted to sixteen States. In the last census year the total crop produced was 472,661,158 lbs., and of this the sixteen tobacco-growing States produced 469,816,203 lbs. For the whole of the United States the average crop per acre was 740 lbs., but it may be taken that for the sixteen tobacco-growing States, the average was about 1,500 lbs. per acre, the variation being from 900 to about 2,000 lbs.

For the purpose of this paper, it has been thought desirable to confine the main body of remarks to the English experiments, and to abstain from referring (except in notable instances) either to the locality in which tobacco is produced in other countries or to the various forms of cultivation practised. Many are more or less familiar with such methods, and I fail to see what good results can accrue from such comparison. For this reason it is difficult to determine the practical value that can be claimed for the lengthy paper upon the subject of "The Cultivation of Tobacco in the North-West of Europe," published in Part II., Vol. xxii, of the "Royal Agricultural Society's Journal," inasmuch as the notes in question are almost entirely devoted to foreign cultivation, and embody, to a very large extent, the opinions of cultivators in climates very different from that of England.

English farmers can have nothing to do with foreign producers of tobacco. The fact remains that something like fifty millions of pounds of tobacco are annually consumed in this country; and the question to solve is, "Shall we grow it ourselves or buy it from the foreigners?"

Mr. Kains-Jackson writes as follows in *The Farmers' Almanack* for 1887:—

"For half a century nearly the illustrations given of current events have never included amongst the products of an English harvest a crop of tobacco. It

was reserved for 1886 to see the plant cultivated and dried in Great Britain as a farm crop.

"Our English growers have this encouragement—that English soil and climate have undoubtedly produced tobacco plants of astonishing luxuriance, and that whatever failure ensues—and failure in several respects is not likely to be avoided this first season—will carry with it its own explanation and cure.

"Like many other things, the English climate has proved not so bad as report made it. What was said to be impossible—the rearing and maturing the tobacco plant in England—has been accomplished, and this season's results are thought as not unlikely to be the beginning of a new and great industry in the United Kingdom."

Sir John Sinclair, in his General Report of Scotland, says:—"During the American War this article (tobacco) became so dear that several unsuccessful attempts were made in Scotland for its cultivation. The chief seat of that new culture was in the neighbourhood of Kelso," where "it succeeded so well that 16½ statute acres of Crailing brought £104, or £6 7s. 4d. per acre, being purchased by the Government at 4d. per pound." From the agricultural survey of the county of Roxburgh, dated 1794, it appeared that "Tobacco was first grown at Newstead, and eventually many hundred acres of land were cropped with it. The profits were amazingly great, but an Act of Parliament put an entire stop to its cultivation. Mr. Train also gave evidence that land let for tobacco cultivation used to let at £5 an acre, when other land was only fetching £2. A more extensive experiment was made in the Vale of York for a few years before 1782, which had to be abandoned because the penalties laid amounted to £30,000.

In Ireland the duty was removed in 1822, but was re-imposed about 1830. By 1829 or 1830 there were no fewer than 1,000 acres under tobacco cultivation in Ireland. It might be questionable whether if cultivated in this country tobacco would bear a duty of 3s. 6d. a pound, but it must be remembered that we were rapidly becoming accustomed to a much smaller margin of profit than was required by our forefathers. The following amusing extract from Fairholt proves the advantages which had formerly accrued from the cultivation of tobacco in England:—

"It had been extensively grown in Gloucestershire, as appears from the following passage in 'Harry Hangman's Honour, or the Glostershire Hangman's request to the Smokers and Tobacconists of London,' a quarto pamphlet in the King's Collection, June 11, 1655. He says—'The very planting of tobacco hath proved the decay of my trade, for since it hath been planted in Glostershire, especially at Winchcourt, my trade has proved nothing worth.' He adds—'Then 'twas a merry world with me! for indeed before tobacco was there planted there being no kind of trade to employ men, and very small tillage, necessity compelled poor men to stand my friends by stealing of sheep and other cattel, breaking of hedges, robbing of orchards, and what not.'"

In Belgium, an ordinary year yielded 2,700 lbs. of tobacco an English acre, of which 70 per cent. was first quality and 30 per cent. second and third quality. The first quality sold at 6½d. per lb., and the second and third at about 4½d. The net profit was about £26 an acre. The industry had made the fortune of the frontier town of Blandain, and enabled it successfully to tide over the present agricultural crisis.

Tobacco cultivation is no new institution in Europe, for as far back as 1830 it was grown in Russia, Holland, Denmark, Germany, Italy, France, Sicily, and Turkey, as well as in Persia, Syria, Arabia, and other more eastern latitudes.

A well-informed writer, about the beginning of the eighteenth century, says: "Tobacco can be readily raised in almost all the temperate climates of the globe; and the chief reason why it is not better known to the English cultivator is, that we have laws which prohibit its culture under severe penalties. The cultivation of tobacco in England was finally prohibited by law in 1782." The same writer adds that, "Several tons of Irish-grown tobacco was imported into England about this time at a duty of 2s. a pound, whilst that imported from America paid 3s. a pound duty."

The following is a summary of the laws which prohibited the growth of tobacco in this country fifty years since, and which, with the later enactments under George III. and William IV., govern the existing prohibitions:—

"By Charles II., c. 34, no person shall plant any tobacco on pain of forfeiting the same, or the value thereof, or 40s. for every rod or pole of ground planted with it (equivalent to a duty of £320 per acre); half to the King and half to him who sues. And besides the said penalty by 15 Charles II., c. 7, he shall moreover forfeit £10 for every rod or pole; one-third to the King, one-third to the poor, and one-third to him who sues.

"By 22 and 23 of Charles II., c. 26, the justices shall, a month before every sessions, issue their

warrants to all high and petty constables to search what tobacco is planted, cured, and made, and by whom; and to make presentment of such persons; which presentment shall be filed by the Clerk of the Peace in open sessions; such filing to be a sufficient conviction of the persons presented, unless such person having notice given him of such presentment, shall, at the next sessions, traverse the presentment, and find sureties for prosecuting and trying such traverse.

"All the constables, &c., shall, within fourteen days after warrant from two justices, pluck up, burn, consume, or tear in pieces, and utterly destroy all tobacco, seed, plant, and leaf sowed or growing in any field or ground.

"And if any tobacco shall be suffered to grow or be consumed in seed, plant, or leaf by the space of fourteen days after the receipt of such warrant by the constables or other officers, they shall, for every offence, forfeit 5s. for every rod, pole, or perch, planted with tobacco; half to the King and half to him who sues.

"But, by the several Acts, nothing in them is to hinder planting tobacco in gardens for physic or surgery, so that the quantity planted exceed not half a pole of ground."

These penalties failing to stop the cultivation of the plant, another Act was passed. By 15th Charles II., c. 7, sections 15, 16, and 17, the tax of £320 was raised to £1,600 per acre, and that exists to the present day.

The cultivation of tobacco in England was first prohibited during the Commonwealth, and as an anecdote connected with this subject, it may be mentioned that Oliver Cromwell ordered upon one occasion, a troop of horse to enter into a field and trample down a tobacco plantation; of so much consequence, while we had colonies, was the trade with such colonies esteemed. Now, however, as the North American States have been long since an independent Government, there appears no substantial reason for such laws as the preceding continuing in existence.

Adam Smith, in his "Wealth of Nations" (Book I., chapter xi.), says:—

"Tobacco *might* be cultivated with advantage through the greater part of Europe, but in almost every part of Europe it has become a principal subject of taxation, and to collect a tax from every different farm in the country where this plant might happen to be cultivated, would be more difficult, *it has been supposed*, than to levy one upon its importation at the Custom House. *The cultivation of tobacco has, upon this account, been most absurdly* prohibited through the greater part of Europe, which necessarily gives a sort of monopoly where it is allowed."

That excuses have been allowed from time to time for the cultivation of tobacco on an extended scale is shown by the following paragraph from Marshall's Reports to the Board of Agriculture, 1815:—"Of tobacco a considerable patch was cultivated at Rothwell, in Northamptonshire, in 1806, for the purpose of dressing sheep for the scab."

With respect to the risks of cultivators evading the Excise, Mr. Meadows Taylor, in his excellent treatise describing the French system of cultivation, says:—

"Our wary Gascon peasant is far too wide awake to run the risk of the loss of his licence, joined to a ruinous fine, for the sake of pilfering a few pounds of bad, unsaleable tobacco. I say unsaleable, because the peasant would first have much difficulty in obtaining in secret good dried leaf, and then to convert this into smoking tobacco. The process of fermentation is only to be properly got through by operating on large quantities."

With the object of determining whether any variety of tobacco was better adapted to our climate than another, Messrs. Carter decided to plant a given quantity of each of the seventeen sorts of which they had imported seeds. Of these two gave evidence of apparently being too delicate to withstand the effects of our uncertain English summer, *i.e.*, the "Kentucky," and the "White Burleigh," inasmuch that the plants appeared to ripen off before the full growth was reached; this was especially apparent upon the wet portion of the land. The appearance of these varieties led some writers to assume that their cultivation was a failure, but after experience did not tend to indorse that opinion, and it is necessary to wait until the tobacco is manufactured, when the relative values of the different kinds will be ascertained. It is, however, admitted that the early maturity of "White Burleigh" and "Kentucky" is a natural result, and these two varieties will unquestionably become favourites with many future cultivators desirous of producing colour rather than quantity, especially in instances where the soil is of a warm character, or in protected situations, the beautiful golden hue of the dried leaf having been pronounced by several authorities equal to anything that can be produced elsewhere.

A further result of this extended trial of varieties has resulted in Messrs. Carter being able to divide the tobaccos into two sections, an arrangement that will doubtless be found

acceptable for the future guidance of cultivators.

The one section is well represented by the "Kentucky," and may be described as semi-erect leaved, the main stem of the plant being more or less hidden by the pale green foliage.

The opposite section is composed of those varieties having pendant leaves, and may be described as "horizontal-leaved," the surface of all of which become more or less corrugated as the plants mature, the colour of the leaves being of a deep green, with the main stem very prominent. Of these the variety known as "Big Frederick" may be taken as a good type. The relative qualities of the leaves are also governed by this selection, those of the latter section being of considerably greater substance or more "leathery" in texture than the "Kentucky."

I will now proceed to give a short description of Messrs. Carters' tobacco crop, grown at Bromley in the season of 1886. The tobacco crop comprised an area of about three-quarters of an acre; the land—which was hired at a high rental, conveniently near to London, and permitting of a daily inspection—was almost a dead flat, low-lying, and so indifferently drained, that in May last, and less than a month from the period at which the land was planted, some parts were almost under water. From this cause also it was found impossible to obtain the fine tilth considered as most desirable in the production of tobacco. The land partook more or less of three characters, the lower portion being a black vegetable deposit, retaining the moisture most tenaciously, the middle section was a rich sandy loam, whilst the top end of the field worked off to a light gravelly soil.

The tobacco seeds were sown on hotbeds, April 7th, 1886 (very late), and the slow growth made by the plants in the earliest stages was most disappointing. This, however, was partly accounted for by the prevalence of unusually cold east winds, to the effects of which the plants were more or less subject, inasmuch as if the hotbeds had been kept close, the plants would have become drawn, weakly, and unsuitable.

As a consequence it was found quite impossible to plant the land as early as had been contemplated, and it was not effected until June 16th, when, the land having been ploughed into ridges three feet apart, the tobacco plants were put into the ground at a uniform distance of three feet from each other, and thoroughly well watered. The weather then appeared more promising, but almost immediately afterwards the wind again veered round to the north-east, and a week of dreadfully cold and sunless weather was experienced.

These very ungenial atmospheric conditions were succeeded by nearly a month of persistent sunshine by day, whilst the night temperature registered unpleasantly low, with an utter absence of rain until July 7th, when a few drops fell for the first time upon the plants. From this period the following particulars mark the development of the crop, at the same time showing the anxious solicitude evinced by the Board of Inland Revenue:—

July 8.—*Excise officer made first visit.*
,, 17.—Stormy. Plants growing very fast.
,, 19.—Tobacco hoed the second time.
,, 20.—Heavy rains.
,, 23—Stormy. Tobacco growing rapidly.
,, 27.—Commenced "earthing up" tobacco.
,, 29.—*Excise officer made second visit.*
Aug. 5.—Finished "earthing up" tobacco.
,, 9.—Commenced "topping" the tobacco.
,, 11.—*Excise officer made third visit.*
,, 12.—Tobacco hoed the fourth time.
,, 20.—*Excise officer made fourth visit.*
,, 24.—"Suckering" the tobacco.
,, 26.—Found first caterpillars attacking plants.
,, 28.—Closed an extremely hot week.
Sept. 7.—*Excise officer made fifth visit.*
,, 10.—Tobacco beginning to ripen.
,, 11.—Slight frost at night.
,, 13.—*Excise officer made sixth visit.*
,, 17.—Sharp frost, dry east wind.
,, 18.—Another frost. Commenced cutting tobacco.
,, 27.—Finished cutting and housing tobacco.

Very elaborate statistics were kept of the average weekly height of each variety (at the later periods after being topped), *i.e.*, after removing the head or flowering stem; and it was observed, from these statistics, that the principal growth was made during the month of August, but in an ordinary spring the planting of the crop may be safely conducted about the middle of May, when the harvest would be proportionately early—a most desirable consummation, as rendering the after curing more simple and certain.

Careful record has also been kept of the average relative weight of each variety, and in addition of the aggregate production of the entire crop, which comprised 3,846 plants at the time of cutting, weighing 5,161½ lbs. The plants were placed a yard apart every way, and the number of plants thus occupying an acre being 4,840, the total weight produced per

acre (upon the above average) would be about 6,200 lbs.

Some experts calculate that the plants shrink at least 60 to 75 per cent. in the process of drying and stripping from the main stem, so that there should remain about 12 cwt. to 24 cwt. of tobacco from an acre, available for disposal to the manufacturer at a price ranging from 4d. per pound, according to the quality.

It will be admitted that these figures point to the cultivation of tobacco as a remunerative occupation, and it may reasonably be expected that if at any future time the Government in their wisdom can devise means to collect the revenue in a way which shall not unduly interfere with the interests of the home producer, and without endangering the sum total of this important source of revenue, the cultivation of tobacco will soon become universal in those districts best adapted to its requirements.

Harvesting.

The process of harvesting was as follows. A certain number of men were provided with ordinary shoemakers' knives, and proceeded to cut the plants row by row, severing them just above the ground. The plants were then laid upon the ground, and left thus upon the land until the next day, care being observed that no damage was done by cold during the night. By this process the leaves—which, in their growing state, are more or less brittle—became limp and wilted, so that they could be handled with less risk of damage. A second group of men made incisions at the thick end of the stem; whilst others, again, threaded the plants—averaging about six plants to a hazel rod—upon rods, specially prepared. These, in their turn, were carried to the waggon.

The plants were then carted to the barn, and after the tobacco upon each rod had been weighed, they were suspended to the rafters, great care being taken that the plants did not touch each other, either upon the rods or in the tiers.

The curing of the plants commenced immediately the housing of the crop was completed, and the process is admitted to have progressed satisfactorily, although the conditions were not by any means the most favourable, inasmuch as no adequate provision had been made for the proper "firing" of the tobacco; in fact, it was found necessary to hire an ordinary barn near the growing crop for this special purpose, very exposed and not proof against the weather, as the only available structure, whilst it was quite impracticable for upwards of five weeks to "fire" the crop (in consequence of the difficulties of insurance), a process highly necessary during wet weather.

Instead of this treatment, the first stages of "curing" were by cold air. This operation is at all times accompanied by a considerable amount of risk of damage to the leaf by mildew and decay, as well as being much slower than the "firing" system.

These imperfect conditions will, however, be easily overcome in the future, and the simple preparations requisite for the proper curing of the crop will doubtless be provided by those who continue these interesting experiments.

It has already been stated that the first stages in curing the tobacco were confined to "cold" drying only. This process consisted in a most careful daily watching of the atmospheric conditions; thus, during the prevalence of dry easterly winds, or cold bright weather generally, the freest possible ventilation was given, the barn doors being opened fully, so that the wind could play directly upon the tobacco. In moist, foggy, or humid weather, on the contrary, the doors were kept as close as possible, and contact with the outside air avoided. This treatment was continued for nearly five weeks, *i.e.*, until about October 25th, when the difficulties of fire insurance were surmounted, and the first fire lighted; and not one day too soon did these changed conditions take place, the weather of the last ten days or a fortnight before fires were used being remarkably damp and foggy, and the tobacco began to show unmistakable signs of mildew. At the same time undue haste in firing cannot be recommended; in fact, several experts who have given very pronounced opinions upon the superiority of the tobacco produced by Messrs. Carter, as compared with examples differently treated, expressed a decided opinion that the excellent quality of this tobacco was largely due to the slow process of curing; and, except in cases where bright golden colour in the leaf is aimed at rather than smoking quality, it is deemed desirable to cold air dry the tobacco, say for a fortnight or three weeks if the weather is fine and dry; if, on the other hand, the air is wet, and the atmosphere heavy, then slow firing should be commenced at once. By slow firing it is meant that a sufficient heat should be produced to dry up any atmospheric moisture entering the building, and also to absorb a certain quantity of

that exuded from the leaves and stems of the tobacco.

Messrs. Carters' tobacco was submitted to this treatment, and a moderate "firing," as suggested above, was continued for about a month.

Eventually, on or about November 25th, the tobacco, which, in the process of drying had already shrunk in bulk nearly 50 per cent., was packed as close as possible, and canvas walls were constructed to make the area as confined as possible, and thus to increase the temperature. By this process an average range of day heat of from 80° to 90° was obtained and continued for four or five days, when the tobacco was considered sufficient cured to be taken down and handled.

The apparatus for heating the barn, a specimen of which is on view, and which is called a "Devil" furnace, suggested itself to Messrs. Carter as serving the required object, under circumstances that rendered a naked fire utterly impossible, the barn being a huge wooden building in the centre of cowsheds, stables, stacks, &c., that must have been destroyed had a fire taken possession of the barn.

In the first place, the furnace was portable, and thus could, if necessary, be readily moved; secondly, wood of any and every description, could be consumed in the furnace, and the novel "cap" or umbrella-shaped dome, combined with the side-guards, was successful in checking the escape of sparks and flame, whilst the peculiar formation of the dome assisted in the distribution of heat.

The tobacco being pronounced sufficiently dry, or cured, the fire is put out, and the outside air freely admitted. This precaution, after high firing, is most important, as the tobacco, in the process of drying, becomes so brittle that at the slightest touch it crumbles into a snuff-like condition. The object of a free circulation of air is to soften the leaf, and render it pliable and easy to handle. This condition—known by Americans as "in case"—will be produced in a day or two, according to the weather, after firing has ceased, when the tobacco should appear to the touch more like thin kid leather than anything else to which it may be compared.

Stripping and handling is an important feature, as bearing upon the value of the manufactured article, it being the special duty of the individual removing the leaves from the plant to sort the leaves when stripped into three qualities, familiarly known in America as "Lugs," *i.e.*, those leaves nearest the ground, usually more or less damaged; "Firsts," the brightest and best coloured leaves; and "Seconds," the medium quality leaves; and it will, in a great measure, depend upon how this sorting is done to determine the market value of the whole of the produce. It is, however, an art easily gained after a little experience; and a knowledge of the proper selection of the leaves is acquired after a lesson or two from some one who is familiar with the operation.

"Handing" the tobacco consists of the leaves being picked up from the table by women and children, the butt ends being placed together, and the number determined upon—from twelve to twenty leaves—being neatly bound round with another leaf of the same kind, the end being secured by insertion between the leaves.

After the hands are "tied" or "bound," as already described, they are passed through the closed hand of the workers, to bring the tobacco into a smaller compass; this is repeated several times as the hands are passed from one worker to the next, and ultimately to the packer, who carefully piles the "hands" of tobacco into a solid block, composed of the width of two hands, the butts coming to the outside of the pile, and the tips of the leaves to the centre. In this manner the tobacco is packed into a small compass, the usual size of the piles being about six feet in length by three feet in depth when trodden down by the packer, care being taken to have the floor, upon which the tobacco is laid, quite clean.

With the object of pressing the tobacco in bulk as much as possible, each layer, as the heap enlarges, is trodden firm in the centre by the packer, who usually wears a pair of slippers during the operation, so that no dirt may become mixed with the tobacco.

This process of treading assists the more rapid fermentation of the tobacco, which is the object sought to be gained by packing down.

It is in this process of fermentation that the greatest care is necessary to avoid overheating, and the bulk must be examined occasionally to guard against such a calamity; if, upon examination, the heat appears to be excessive, the safest plan is to pull the stack to pieces, let it cool down, and then re-bulk it. Any extra trouble taken with the tobacco in this stage will be amply repaid by its superior condition, and ultimately by the increased market value over produce less carefully handled.

The tobacco when in this condition should, if possible, be disposed of to the manufacturer (or to the depôt, such as it is hoped will be forthcoming in various agricultural centres, as the cultivation becomes more general), who will (as in France under the Régie Nationale) undertake its development through the second fermentation in spring, familiarly designated the "May sweat" by Americans.

This is the final stage, and after such fermentation it is usual, in foreign tobacco-producing centres, for the crop to be packed into cases or hogsheads, and sent into the market.

It will, however, be remembered that in the experiments I am now describing, it was impossible to pursue such treatment; and as the tobacco passed into the hands of the manufacturers in December, 1886, records of "Spring" treatment must be reserved for future observation.

The successful culture of tobacco may be summed up in a very few words: attentive observation of the rules laid down by English experimentalists, rather than attempting to follow the customs of other nations, which are frequently impossible or undesirable in this country; and the exercise of daily observation, which will often suggest some improved system of procedure.

I am favoured with the following report of an analysis—so far as completed—of Messrs. Carters' tobacco, now being conducted by Dr. Bell, at the Laboratory, Inland Revenue, Somerset-house, but which was not perfected at the time of going to press.

English Virginia (partly cured).

	Per cent.
Nicotine	4·2
Ash	21·7

Nearly a maximum.

In imported Virginia Tobacco the average is :—

	Per cent.
Nicotine	3
Ash	18

I have compiled the approximate cost of cultivating an acre of tobacco as follows :—

	£	s.	d.
Rent of land and buildings, including rates, tithes, and taxes, at 60s. per acre	3	0	0
Three ploughings at 10s. per acre each time	1	10	0
Two harrowings at 1s. per acre each time	0	2	0
Nine loads farm-yard manure delivered on land	2	8	0
Spreading farm-yard manure	0	1	3
3 cwt. Peruvian Guano at £12 per ton	1	16	0
5,000 plants at about 15s. per 1,000	3	15	0
Planting ditto, 1 man 1 day 3s. 2d., 1 boy 1 day 1s. 3d.	0	4	5
Two horse-hoeings at 3s. per acre each time	0	6	0
Manual labour, hilling and side-hoeing twice over at 7s. per acre each time	0	14	0
Pruning, topping, and suckering at 8s. per acre	0	8	0
Cutting at 5s. per acre, carting to barn and hanging at 12s.	0	17	0
Firing, two loads waste hard wood to be found on the farm (charge for labour only)	0	16	0
Man's time curing and attending, &c., two weeks at 15s.	1	10	0
Stripping, sorting, bulking, and packing, say 3,200 lbs. at 5s. per 100 lbs.	8	0	0
	£25	7	8

And assuming this to be the cost, and that the produce is sold at not less than 4d. per pound, Messrs. Carters' experiments work out a net profit of from £10 to £24 per acre. The seventeen balance-sheets from which I derive this information will be found fully set out in a book on English tobacco culture which I have compiled, and shall shortly publish, and which her Majesty the Queen has graciously permitted me to dedicate to her.

The concluding words of an interesting paper, written by an American, upon the subject of tobacco, will fitly conclude the remarks I have had the honour to make to you to-night :—

"If you have not a large stock of patience and perseverance, with a will to learn, and a resolution to keep trying until you succeed, you have missed your calling, and had better try something else; for there is no royal road to success in tobacco raising. But if you possess the true essentials—have the true and lasting pluck—you will succeed, soon, or late, and what is better, reap a full reward for honest, faithful toil."

DISCUSSION.

The CHAIRMAN said everyone must have been much interested in the paper, but no doubt it would have occurred to many that there were great difficulties to contend with in the growth of tobacco in England. Still, reverting to the closing words of the paper, he believed that British pluck would overcome them. As a small grower himself last season, he must admit frankly that he had made some mistakes, and probably other experimenters had done the same; but he had learned by experience, and another year he hoped to be still more successful. One of the greatest mistakes he had made was to allow too many leaves to grow on each plant, thus to some extent deteriorating the quality; if he had only allowed seven or eight leaves instead of eleven or twelve, the quality would have been better. Again, from the trials which had taken place, valuable information had been derived as to the variety best suited for growth in England, and future error in this direction would be avoided. The difficulty of curing was

perhaps the greatest of all, and some might say it was no use leading people to think that they could cure tobacco of a valuable quality in England, especially small farmers, and even labourers as had been suggested; but he thought if a certain number in a district were desirous of growing tobacco, arrangements might be made to send the crop to one curing-house, where it should be done under the superintendence of a skilful man who thoroughly understood the process. One of the greatest obstacles was that at the outset they were confronted with a tax of £1,600 an acre, or in other words a protective tax of 500 per cent. in favour of the foreign grower. They boasted all over the world that England was a free country, but in this case there was the rankest protection, and it was in this direction that efforts should be made by our legislators if the culture of tobacco in England was to be encouraged. The Chancellor of the Exchequer must be persuaded to devise some means not only to protect the revenue, but to encourage this important branch of agriculture. Mr. Beale had alluded to the first Act of Parliament in England, an Act for prohibiting the growth of tobacco, passed in the reign of Charles II., and it might be interesting to read the preamble of that Act. Having done so, he pointed out that the Act was passed with a view of encouraging the American Colonies, but as these no longer belonged to Great Britain, he contended that, excepting for the sake of the revenue, there was no reason why this restrictive legislation should be continued. The quantity of tobacco imported into England, in 1884, was 56,695,000 lbs., and we paid foreigners no less than £3,715,000 for it. He and others had for some time been asking, in the farmers' interest, for greater freedom of cropping, and he for one felt very strongly that the modest man who smoked 2 ozs. of tobacco a-week, and contributed 10s. per annum to the revenue, should be able to smoke that which he grew in his own garden. Then the Chancellor of the Exchequer might step in, and say how was the revenue to be protected. He admitted it was indispensable that a certain duty should be paid, but why should there not be a lower duty on home-grown tobacco, which could never be of the same quality as that imported, and if it were necessary, have a rather higher duty on the foreign. This question was an important one in many ways; it was immensely important with regard to the amount of labour which would be employed, and also as regards agriculture generally, if tenant farmers could see their way in this, their time of distress, to take it up, probably to a limited extent at first, and if they received encouragement—and further statistics, such as he hoped would be forthcoming this year, proved that by this crop the farmer could, after paying rent, taxes, and labour, receive a much higher income than he was at present deriving from wheat or corn—it would be a great boon. Special thanks were due to Messrs. Carter and Mr. Beale, and also to Lord Harris, Mr. de Laune, Mr. Kains-Jackson, and others who had taken up this question at considerable cost, and who, like himself, had had a great many worries and anxieties in connection with it; but that they did not mind if they could in any way advance this new trade, as he hoped it would turn out to be. The Inland Revenue officers had done their duty most efficiently, and he and his friends would always welcome them, as they had done, to come and see the crops at any time, and to inspect the whole process of curing. Sir Algernon West, who was at the head of the Inland Revenue Department, was anxious to meet them in a friendly way, and he was glad to say that it had been announced that a statutory declaration in the following form would in future be accepted, instead of finding sureties in £100:—"I, A. B, cultivating tobacco at ——, in the county of ——, declare that I will afford to the officials authorised by the Board of Inland Revenue free access at all times to the grounds and places used for the cultivation of tobacco, and that all the tobacco grown by me shall be duly produced to the proper revenue officer, to be charged with duty or otherwise disposed of, in accordance with any regulations which may be issued relating to the growing of tobacco." That was a very fair proposal, and would, he thought, give much encouragement to further experiments during the coming season. As a humble member of the Council of the Society, he was perhaps rather to blame for not asking permission for anyone who wished to try the English-grown tobacco that evening, so as to have a smoking lecture, instead of merely seeing the dried tobacco hanging up. He would now call on Mr. Kains-Jackson, who had presented a valuable report on this subject to the authorities.

Mr. Kains-Jackson said he commenced his study of this subject by learning to smoke. It happened quite fortuitously that he took up this question, from a conversation with Mr. de Laune, who first set the ball rolling; Lord Harris, who is a well-known batsman, sent it back again; then Sir E. Birkbeck threw it up in the House of Commons, where both parties agreed that it was worthy of discussion, though they could not see their way to do anything, and then, by the merest chance, it fell into his hands. He went to Somerset-house and asked for an answer that day, whether the growing of tobacco would be allowed. The chairman of the Board said they did not do things in such a hurry as that, when he told him that he wanted to tell his people next morning what they were to do. Thereupon the chairman said he would see Sir William Harcourt about it, and that after he (Mr. Jackson) received the first conditions on which tobacco might be grown, and they were published in the papers next morning. The Chairman and Mr. Beale had really left very little to be said, but he should like to assert, very confidently, that tobacco could be grown, for he had seen nearly every experiment which had been tried,

and he had been astonished at finding the tobacco plant growing in such luxuriance. He believed it would ultimately prove to be a source of wealth to farmers, and, if so, it was hardly likely that any Government would prevent its growth. Only a few places had been mentioned by Mr. Beale, but there were few counties in England where it had not been grown this year; not always on a field scale, but he could mention about 100 places where it had been grown successfully. Sir John Lawes wrote to him that it was a good plant this year, but there had been a wonderful autumn, and he feared a great many more would be trying it next year. It might have been a good autumn, but it was a wonderfully bad spring, when, for about six weeks, the crops were nearly perishing from drought and east winds. On the whole, therefore, the weather was not above the average, and he thought in ordinary seasons tobacco could be grown successfully, especially as the Secretary of the Royal Agricultural Society had found, on making inquiries, that the tobacco leaf did not require to be manured before cutting, as many supposed; but, on the contrary, it was all the better for being cut just before it was ripe. At one time they used to cut wheat "dead ripe;" but now it was always cut green. He had seen tobacco growing in Holland and France, and the latter, if not so good as that grown in Havanna, was quite good enough for the French people; and in the same way, he was satisfied tobacco could be grown here which the English people would be glad to smoke.

Mr. Druce, looking at the subject from a farmer's point of view, asked if the cost stated in the Table included all the expenses incurred in cultivating the crop. He saw that rent, rates, and taxes was put at £3 an acre, which was a high rent for agricultural land, but he did not think it high for the class of land Mr. Beale described, situated so near London. Then three ploughings and two harrowings were put down, but he ventured to doubt whether two harrowings would be sufficient to bring an ordinary soil to the state of very fine tilth of which Mr. Beale spoke. He had no fault to find with the next two items, but then he came to two-horse hoeings, and manual labour tilling, and side hoeing twice over. He ventured to think that if the crop was to be grown, as no doubt it should be, quite free from weeds, two-horse hoeings were hardly sufficient, and that the amount charged for side hoeings was much less than it should be. An ordinary crop of swedes would cost as much for hoeing as those two items. He should also like to know from the Chairman and Mr. de Laune if the sum stated, £25 odd per acre, was about what it cost them to grow it. And if that were the correct figure, it would at once explain why, in the present condition of things, very few farmers did grow it. The cost of an ordinary crop of wheat might be put down at about £8 an acre; working out the figures for a number of places, chiefly in the eastern counties, he found the average was something like seven guineas. This amount was more than three times that, and, therefore, it behoved the farmers to wait a little before committing themselves to so heavy an expenditure per acre. It was often said of the English farmer that pioneers showed him the way, and he was very slow in following it; but there was a good deal of common-sense in him, and he thought it would be wise not to grow a crop until he saw a fair prospect of its paying him. The whole cost could not yet be arrived at, because he understood from Mr. Beale that the ultimate process of curing, so as to render the tobacco fit for consumption, had not yet been gone through. Lastly, tobacco was understood to be a very exhausting crop, and he should like to know how often it could be grown on such a soil as had been described, and what crops must intervene.

Mr. E. J. Beale said there had been no opportunity yet of gaining the experience in England necessary to answer the last question, because until last year they had not been allowed to grow it; but last winter he was at Stockholm, where he met a tobacco grower who had grown it for fifty years successively on the same ground. He need not, of course, remind a practical farmer that whatever you took out of the ground you must put in again. But this man did not grow the crop for the glory of God, or anything of the sort, but to make a profit by it. He stated at the beginning of the paper that he recommended caution in the matter of area in future experiments, so that it could not be said that he wished to rush the tenant farmer into a large expenditure before he was on firm ground. Mr. Druce had very fairly criticised his financial estimate, and asked if that was the actual cost, and his answer was frankly no. He had given all the items, and practical men could adopt or reject any of them. He could not put forward the actual cost for these reasons. In the first place it was an accommodation field which his firm obtained from a cowkeeper, who charged £6 or £7 an acre for it, and it would not be fair to charge such a rent as that. Again, they had no farming appliances within fifty miles of it, and had to go to their neighbours. He had a farm fifty miles off, but they wanted to try this in a place where anybody could easily come and see it. He had no particular interest apart from the credit, if there were any, in pushing this matter, for 5s. worth of seed was enough for an acre, and if it were all profit it would not amount to very much. Another reason why it would not have been fair to put the actual cost was that Messrs. Carter grew seventeen different varieties, some of which they would not grow again, or recommend, not being suited to the climate. They had commenced a systematic experiment, which they intended to carry further this year, when the varieties would probably be reduced to four or five. But even then he should not be able to give the balance-sheet, being still dependent on the cowkeeper, who

would have an extravagant price for the land. The cost of ultimate curing need not be considered, as the whole crop was sold to Messrs. Cope, of Liverpool, who gave 1s. a pound for it; but he did not say that must be taken as a fair price. They looked upon it as a novelty, and were disposed to be liberal. He could not say whether it would fetch 1s. a pound in future, but assuming the cost was anything like £25 or £30 an acre, and anything like the same weight of crop were obtained and sold at 4d. a pound, the price of ordinary tobacco—the average quality which was sold to working men at a cheap price, and that was the tobacco the English farmer must grow—they would clear from £10 to £20 an acre profit. He did not press anyone to try it on a large scale, but he hoped many would try a rod, or half a rod, watch it carefully, and not trouble to sell it, but destroy it afterwards, and then they would be able to judge what the result might be. Sixpennyworth of seed would be quite enough for such an experiment.

The CHAIRMAN said he had before him the rotation of crops in Hungary, and he saw that there the tobacco crop came once in six years, and was always followed by wheat.

Mr. L. MORRIS did not quite understand what the Chairman said about protection to the foreigners, if the English grown tobacco paid no more duty; but he understood him to advocate a lower duty on English grown tobacco, which would be protection for the English farmer.

The CHAIRMAN said the growth in England was, at present, absolutely prohibited by a tax of £1,600 an acre.

Mr. DE LAUNE remarked that any one growing tobacco in England would have to pay a duty of about 36s. a pound, as against 3s. 6d. paid by the foreigner.

Mr. MORRIS said the question was, if the English growers were placed on the same footing as the foreigner, with regard to duty, was there any reason to suppose it could be grown cheaper? would there not be the same competition as in wheat and other produce, which made English farming so difficult. Tobacco was grown nearly all over the world, and there would be the same competition with those countries, some of them much better suited than England for cultivation, and it appeared to him that, without protective duties, the English farmer would be unable to compete profitably.

The CHAIRMAN said his idea was that tobacco grown in England should be charged a lower duty than foreign.

Mr. BEALE said he did not agree with the Chairman about that. The best Havanna cigars were covered with a leaf which was not grown in Havanna. He had a friend in Connecticut who grew tobacco, which had no flavour at all, but it produced a very fine leaf, which he sold at 2s. a pound for wrappers. There were many millions of cigars made in this country, and he apprehended that foreigners would soon discover there was a market for wrappers. He did not think the English farmer need fear Continental competition any more than the English manufacturer. He had to compete with many Continental people, and he was not at all afraid of them, nor was he altogether unsuccessful. The English farmer could grow tobacco quite as cheaply as it could be grown on the Continent, and apart from fiscal matters he was much more free; for instance, he had not to send his sons into the army and, therefore, had an advantage over his Continental competitor, and he would certainly save the carriage.

Mr. MORRIS remarked that there were always people who knew more about a trade than those who were engaged in it. He had been in the cigar trade fifty years, and he had never heard that the best Havannah cigars were not covered with Havannah wrappers.

Mr. DE LAUNE agreed with many of the remarks made by Mr. Druce, and certainly should not say, at present, that tobacco was a farmers' crop; it was, as yet, in the experimental stage. The present movement was very much due to Lord Harris and himself, and, speaking for himself, he must say they did not yet know enough about it to recommend tenant farmers to take it up as a panacea for agricultural depression. For instance, if the regulations laid down in other countries for drying the crop were followed in England, the tobacco would become mouldy, and it was for those who chose to experiment to find out how this was to be remedied, at the cheapest possible cost. He hoped if Government gave any concessions during the next year or two, it would be merely to experimentalists. Mr. Beale had fairly explained how impossible it would be to give an absolute account of what had been spent, so that anyone who read the paper could draw an accurate conclusion. Doubtless another year the cost would be more nearly what had been given as the estimate. He had in his possession the accounts of a gentleman who had grown tobacco, and his absolute cost, speaking from memory, was less than Mr. Beale's estimate. But in spite of that, and though the tobacco might be worth 4½d., 5d., or 6d. a pound, he could not advise a farmer who did not know how to make farming pay at present to take up tobacco. Mr. Druce's remarks were very pertinent, that it was not wise for a farmer who could not succeed in what he was doing to rush into every new thing he heard of. If new crops were to be brought under the notice of farmers, it should be

done by those landowners who could afford to burn their fingers for the first year or two, and by those large commercial firms who were often ready to help in such undertakings. He hoped no one would run away with the idea that farmers were being advised to grow this crop for a year or two, until they knew more about it.

Mr. WILSON said he had had no experience in growing tobacco, but he might suggest something which might be useful to those who were experimenting. He understood that in the drying process sometimes the fermentation got too fast, and the stack had to be pulled down and repacked. He had a patent process for pressing ensilage by hydraulic pressure, which he should be happy to lend anyone engaged in these experiments, which he thought would meet the difficulty. The temperature could be ascertained at any time by means of a thermometer, and if it were getting too high you only had to apply a little more pressure, and it was reduced at once.

Mr. BEALE drew attention to a possible pest which might follow the introduction of tobacco culture, viz., a tobacco moth, which he had imported from America. The caterpillar of this moth gave the Americans a great deal of trouble.

Major CRAIGIE asked if Mr. Beale could give any explanation of the decline of tobacco growing in some of the continental countries of recent years, especially in Hungary.

Mr. BEALE said it was a long while since he had been in Hungary, but tobacco there was a Government monopoly which was quite enough to account for the decline of any industry.

The CHAIRMAN then proposed a cordial vote of thanks to Mr. Beale for his interesting paper. He hoped that both he and Mr. de Laune would go on in the energetic way they had began, and endeavour during the next few years to put this matter to the most severe test possible ; that the figures they would be able to present to the Government would be such as to settle the question once for all whether tobacco growing in England could be made profitable.

Mr. BEALE, in reply, repeated what he had before stated, that his firm had no desire to lead the British farmer into growing tobacco on any large scale at the present moment. He was much obliged to Mr. Druce for his very practical remarks, and he hoped he would try it on a small scale, and that farmers would do the same, so as not to be guided entirely by hearsay or the experiments of other people, but would apply that practical common sense for which the British farmer was celebrated. By this means, and with the aid of wealthy landowners, he had no doubt that tobacco would eventually become one of our staple crops.

Miscellaneous.

ELECTRIC LIGHTING BILL.

The Electric Lighting Act (1882) Amendment Bill was read a second time in the House of Lords, on Tuesday evening, 1st inst.

Lord THURLOW said that, in asking their Lordships to give a second reading to this Bill, he desired to say that its subject was not new to him, as he had for the last five years been practically and commercially connected with the industry, and had for four years been one of the few members of their Lordships' House who had had electric light in his own house, and thus had daily opportunity of studying it and of appreciating its comfort and convenience. It would be interesting to know how many of their Lordships actually had introduced electric lighting into their houses. He should think a dozen or a score would be the outside. Among them, however, there was, he was glad to say, the leader of the House, the noble Marquis, the head of the Government, who had the honour of having been one of the earliest and most successful pioneers of electricity, not only in connection with lighting, but with the transmission of power. He could not help thinking that the experience of the noble Marquis would make him concur with him in thinking that the moment had now come to amend the Act of 1882, under which, as it stood, central lighting stations and house-to-house lighting were a commercial impossibility. Their Lordships must remember the circumstances under which that Act was passed. The science was then in its infancy. Not long before Lane-Fox and Edison had made discoveries in filaments and attachments that had for the first time made incandescent lighting practically possible. Electric lighting then rapidly became a medium for the heaviest gambling in shares known since the South Sea Bubble. So great was the notoriety of this gambling that the Government of the day felt bound to step in to prescribe rules for regulating and arresting the flow of capital into all kinds of hasty and ill-considered schemes. All this had now completely changed. The gambling spirit that raised £5 shares to £60 had passed away, and been buried in the ruins of many of the companies which were then promoted, and the stage of leisurely repentance had been reached. Meanwhile, immense progress had been made in every branch of electric lighting. One branch of the subject, almost unknown in 1882, and now justly considered as a necessary element in successful incandescent electric lighting—namely,

cells or accumulators for storing electricity—had now been practically perfected. Without storage batteries engines and dynamos must be kept constantly working, and the light, which flickered always more or less with the pulsations of the engine, was injurious to the eyesight and unsatisfactory. Of course, much work remained to be done. Reliable and simple meters were still required, but the position had quite changed. Electric lighting was no longer a dream of the future but a reality, and commercially possible but for the Act of 1882. For example, ship lighting, subjected to no trammels, was now being universally adopted by all the great companies, the Cunard, the P. and O., the German Lloyd, and by the navies of the world. Even great buildings large enough to make them independent of central lighting stations and able to generate electricity for themselves had adopted it, such as Buckingham Palace, the Grand Hotel, the Métropole and First Avenue Hotels, several theatres, the Athenæum Club, the Junior United Service Club, the Junior Carlton, South Kensington Museum, the Grosvenor Gallery, and many more; but house-to-house lighting remained an utter impossibility, as capital could not be raised under the onerous provisions of the Act of 1882 for central lighting stations. Let their Lordships compare with this state of things the position of the science abroad and in America, where it was estimated that upwards of £32,000,000 of which £21,000,000 were in arc and £11,000,000 incandescent, had been invested in electric lighting. To come, however, to the Bill before the House, their Lordships would remember what passed on the subject last year, when three Bills were introduced. For Bill No. 1 he was himself, to a large extent, responsible, as it was the Bill of a committee of experts and scientific men who had considered the matter for two years, and over which he had the honour to preside. That Bill aimed, no doubt, at too much. Its object was to put electricity on the same footing as gas. This was considered as a desire to set up a second monopoly, while the real object was only to enable it to compete successfully against an existing monopoly. Bill No. 2 was brought in by a noble Viscount, not now in his place (Lord Bury), whose knowledge of the subject was accurate and extensive, and Bill No. 3 was the Government Bill. Those three Bills went to a Select Committee and important evidence was heard, among others that of Sir F. Bramwell, Mr. Preece, Mr. Forbes, Mr. Hucks Gibbs, Mr. Cohen, and Mr. Crompton. The result was the amendment of the Government measure, Bill No. 3, and in that amended shape it would have passed into law had it not been for the change of Government and death of the Parliament. The present Bill was founded on that Bill with only one addition. It was last year's Bill No. 3, as amended in Committee with "good-will" added. It only amended the Act of 1882 as regarded Clause 27, which dealt with the compulsory purchase of an undertaking by a local authority. The clause as it stood had been irreverently called the "old iron clause," because under it property was to be compulsorily bought at its break-up value irrespective of its value as a going concern, after only twenty-one years. The effect of that was to compel undertakers to charge such a rate for electricity as was practically prohibitive and prevented its competition with gas. On this point he must confess to holding strong views, and he could not see why this industry should be treated differently from any other in the event of compulsory purchase by a local authority. Indeed, it had some claims to almost preferential treatment on account of salubrity, cleanliness, and safety. It seemed to be only a question of an alternative — either to allow a fair valuation of goodwill of the business or to grant the licence for such a prolonged period as would enable undertakers to recoup themselves without charging a prohibitive price. If 50 years were granted, this might meet the case, but on the whole it seemed wiser to shorten the preferential term and to provide for competition at its expiry. This was the only question really to be settled. All were agreed on other points, such as the lamps clause, continuous supply, &c. The goodwill question was a thorny one, and admitted of much being said on both sides. His desire was to place it before the House as an open subject for the House in its wisdom to decide. He was willing to accept any reasonable amendments in Committee if the House would permit the Bill to be read a second time, and he was willing to postpone the Committee stage to any reasonable date to suit the convenience of the Government and to afford time for deliberation. His only desire was that legislation should proceed this Session, and that an industry which only required fair conditions to progress should, in these days of depression and of large armies of unemployed, go on for the good of trade and of mankind at large. His object was to come to the relief of an industry capable of rendering the most important services to civilisation. His own belief was that before many years they would find the Board of Trade prescribing electric lighting on the score of health and safety in all factories, schools, mines, theatres, churches, and the like; that the gas companies in England would follow the example of the gas companies on the Continent America, convert their plant, and become purveyors of electricity; and that finally Registrar-Generals of the future would be able to trace to this cause increased immunity from consumption and other kindred diseases which infallibly arose to a great extent from vitiation of the atmosphere now breathed. He could only say, in conclusion, that if the Government would undertake to deal with the matter, he would gladly leave it in their hands, and that he was willing to consider all points open to fair consideration in Committee, if their Lordships would accept the view he took of the desirability of speedy legislation, and allow the Bill to be now read a second time.

The Earl of CRAWFORD and BALCARRAS supported the second reading of the Bill, and said that he approved of the payment for goodwill on the compulsory purchase of a successful undertaking.

Lord BRAMWELL said that legislation on this subject was necessary.

The Marquis of SALISBURY said that he inclined, in spite of the terror of the gas and water companies, to go back to ideas of less restriction and greater freedom in this matter, and to allow enterprise to have its full swing, to remove the obstacles which had hitherto impeded it, and offer terms, not such as they thought the capitalist ought to accept, but which they found by experience he would accept. So it might be possible by giving rights which were generous and large, to procure for the public the full advantage of those scientific inventions which other nations had, and which now, by our restrictive policy, we prevented the public from enjoying without doing any good to the local authorities, which were the subject of so much tender care.

Lord THURLOW said he would endeavour to amend the Bill in Committee with the object of meeting the views which had been urged.

POPULATION OF SPAIN.

According to the last census, which was taken on the 31st December, 1877, the population of Spain, including her African possessions, was 16,625,621, distributed over an area of 195,726 square miles, the density being in the ratio of 85 souls per square mile. The increase is very slow, being only at the rate of 33,000 per annum. Her Majesty's Secretary of Legation at Madrid, in his last report, says that at the last census enumeration the population of the principal cities was as follows:—Madrid, 397,816; Barcelona, 248,943; Valencia, 143,861; Seville, 134,318; Malaga, 115,882; and Murcia, 91,805. Besides these, there are forty-three cities, of which thirty have a mean population of under 30,000, and the remainder of between 30,000 and 90,000. Neither the climate nor the topography of Spain are favourable to density of population; but where irrigation is extensively practised, viz., Valencia, Murcia, and Granada, the population per square mile nearly equals that of Belgium. The following figures wtll show the increase of population during the last ninety-eight years:—In the year 1779, 10,000,000; in 1826, 13,000,000; in 1860, 16,000,000; and in 1882, an estimated population of 16,859,000. During the same period, agriculture in Spain has made considerable progress, the extent of land under cultivation in 1779 being 21,000,000 acres, and in 1882 78,000,000 acres, or an increase of 67,000,000 acres. Thus, while the population increased at the rate of only about 65 per cent., the cultivated area has been more than tripled. In 1779, the agricultural population was 5,615,000, and in 1860 it had risen to 9,327,664, showing an increase of 3,712,664 in sixty-three years. The industrial population in 1797 was 1,034,934, and in 1860 it amounted to 3,038,074, an increase of 2,003,140. The unproductive population in 1797 amounted to 3,616,187, and in 1860 to 3,229,493.

Correspondence.

RECENT ADVANCES IN SEWING MACHINES.

Would you permit me to emphasise the regret I expressed in the discussion on Wednesday last, a regret which I believe was generally felt, at the extremely restricted survey which was taken of "Recent Advances in Sewing Machines." The paper was excellent, as far as it went, but it did not go far enough. Confined, practically, to the invention of two or three celebrated firms, it gave no general idea of what had been accomplished in this field of industry since the Great Exhibition of 1862.

Naturally as one, and perhaps the only one present who also had the pleasure of listening to Mr. Alexander's able paper in 1863, I looked for a paper that would have taken up the subject where he left it, and brought the history of invention in sewing machines down to the present day. Such a *resumé* would have shown that many men and many minds, unconfined to a single nationality, but representing English, French, Swiss, German, and Danish, as well as American, had all made important and valuable contributions to the many forms, varieties, and applications of this invention. Indeed, some of the improvements that were shown, such as those connected with the loose wheel and automatic winding arrangements, were purely English inventions appropriated (legally of course) in machines exhibited, but without acknowledgment of the obligation.

The records of the English Patent-office will preserve the names of many inventors who, but for that, might pass away unnoticed and forgotten. But the names of Starley of Coventry; of Westmoreland of Nottingham, the inventor of the semicircular shuttle, and its action as applied in arm machines; of Pitt Brothers, of Cleckheaton, who perfected the universal feed action to the same class of machine; of Winter of Leeds, who first showed how everything was to be met by compensating provisions; and of Morrison of Birmingham, the inventor of the Archimedean hem-folder; these and others should not fail to meet their deserved recognition. So, too, the important inventions in wax thread sewing machinery of Pearson,

of Robinson, and Greenwood and Batley, and the sail-making and herring-bone stitching machinery of Kimball and Morton, of Glasgow, should be duly chronicled. Amongst Continental inventions of transcendent merit, a place should surely have been found for the Danish glove-making machine, and the French, or Bonnaz, embroidering machine. All these are of a date subsequent to the Exhibition of 1862, the period surveyed in Mr. Alexander's paper.

NEWTON WILSON.

Obituary.

EUGENE RIMMEL.—Mr. Rimmel, a member of the Society of Arts of thirty years standing, died suddenly on Friday evening, 25th February, at 96, Strand, in the 67th year of his age. He read a paper on "The Art of Perfumery," before the Society, in May, 1860, and was a contributor to the *Journal.* He was a juror at the International Exhibition, of 1862; and in 1865 he lectured before the Royal Horticultural Society on "The Commercial Use of Flowers." Besides the special subject upon which he was an authority, he exhibited a taste for general literature. He translated *Othello* into French verse, and is said to have been engaged on a similar translation of *Romeo and Juliet* at the time of his death. He was also particularly interested in the establishment of several philanthropic funds.

General Notes.

EMIGRATION.—The Emigrants' Information Office, established under the supervision of the Colonial-office, for the purpose of supplying intending emigrants with useful and trustworthy information respecting emigration to the British Colonies, has issued a series of circulars. They contain information respecting length and cost of passage to the different colonies, arrangements on landing, best time of arrival, present demand for labour, &c. Free passages to Queensland are offered to selected agricultural labourers and single domestic servants, and to Western Australia to a few selected domestic servants. There are no free passages to any other colony. In Canada there is an opening for tenant farmers with capital, for male and female farm servants, and for female domestic servants. There is a demand for agricultural labourers and female domestic servants in Queensland, Tasmania, and Western Australia. There is little or no demand in New South Wales, Victoria, South Australia, New Zealand, the Cape, and Natal, except for female domestic servants. In all the colonies there is an opening for farmers with capital. The circulars can be obtained gratis on application to the chief clerk, at the office, 31, Broadway, Westminster.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

MARCH 9.—"Railway Brakes." By WILLIAM P. MARSHALL. SIR FREDERICK BRAMWELL, F.R.S., will preside.

MARCH 16.—"Machinery and Appliances used on the Stage." By PERCY FITZGERALD. SIR FREDERICK POLLOCK, BART., will preside.

MARCH 23.—"The Living Organisms of the Air; the Effect of Place and Climate on their Prevalence." By Dr. PERCY FRANKLAND. PROF. BURDON SANDERSON, M.D., F.R.S., will preside.

MARCH 30. — "Electric Locomotion." By A. RECKENZAUN.

The dates for the following Papers are not yet fixed: —

"Cottage Industries in Ireland." By MRS. ERNEST HART.

"Miners' Safety Lamps." By EDWARD H. LIVEING.

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

INDIAN SECTION.

Friday evenings, at Eight o'clock :—

MARCH 25.—"Indian Coffee." By FREDERICK CLIFFORD.

APRIL 29.— "Village Communities in India" By J. F. HEWITT.

MAY 27.—"Indian Tea." By Dr. T. BERRY WHITE. H. S. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock :—

MARCH 29.—"Colonial Wines." By RICHARD BANNISTER.

APRIL 19. — "South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

MAY 17.—

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

MARCH 15.—"The Application of Gems to the Art of the Goldsmith." By ALFRED PHILLIPS. SIR GEORGE BIRDWOOD, M.D., LL.D., K.C.I.E., C.S.I., will preside.

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

CANTOR LECTURES.

The Third Course will be on "Building Materials." By W. Y. DENT, F.C.S., F.I.C. Four Lectures.

LECTURE IV.—MARCH 7.—Asphalt described.—Timber: causes which promote its decay.—Methods adopted for its preservation.—Description of the creosoting process.—Painting.

The Fourth Course will be on "Testing Materials of Construction, especially Iron and Steel." By Prof. W. C. UNWIN, F.R.S Three Lectures.

March 21, 28; April 4.

The Fifth and Concluding Course will be on "The Chemical Changes of Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Y. Dent, "Building Materials." (Lecture IV.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. E. Olander, "Bridge Floors; their design, weight, and cost."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Messrs. Cross and Bevan, "M. Hermite's System of Electrolytic Bleaching." 2. Mr. James Mactear, "Castner's Sodium Process," and "A New Method of Elevating Liquids, especially applicable to Acids."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. F. A. Walker, "Oriental Entomology."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Andrew Lang, "Life in Homer's Days."

TUESDAY, MARCH 8...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture VIII.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on Mr. John James Webster's paper, "Dredging Operations and Appliances."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. A. L. Lewis, "Stone Circles near Aberdeen." 2. Mr. J. Cockburn, "Palæolithic Implements from the drift gravels of the Singrauli Basin, South Mirzapore." 3. Mr. Abraham Hale, "Stone Implements from Perak."

Colonial Institute, Prince's-hall, Piccadilly, W., 8 p.m. The Bishop of New Westminster, "British Columbia."

WEDNESDAY, MARCH 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William P. Marshall, "Railway Brakes."

Geological, Burlington-house, W., 8 p.m. 1. Mr. James W. Davis, "*Chondrosteus accipenseroides*, Agassiz." 2. Prof. H. G. Seeley, "*Aristosuchus pusillus*, Ow., being further notes on the fossils described by Sir R. Owen as *Poikilopleuron pusillus*, Ow." 3. Prof. H. G. Seeley, "*Patricosaurus merocratus*, Seeley, a Lizard from the Cambridge Greensand, preserved in the Woodwardian Museum of the University of Cambridge." 4. Prof. H. G. Seeley, "*Heterosuchus valdensis*, Seeley, a procœlian Crocodile from the Hastings sands of Hastings." 5. Prof. H. G. Seeley, "A sacrum, apparently indicating a new type of Bird (*Ornithodesmus pygidius*, Seeley), from the Wealden of Brook."

Graphic, University College, W.C., 8 p.m.

Microscopical, King's College, W.C., 8 p.m. 1. Mr. G. Massee, "The Differentiation of Tissues in Fungi." 2. Dr. H. J. Johnston-Lavis and Dr. G. C. J. Vosmaer, "Section Cutting of Sponges and other similar structures with soft and hard tissues."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Discussion on Mr. Spence's paper, "Construction of Specifications and Trial of Patent Cases." 2. Mr. C. D. Abel, "Notes on the Proceedings of the Commission on the Working of the German Patent Law."

Shelley, University College, Gower-street, W.C., 8 p.m. Dr. B. L. Moselay, "Miss Alma Murray as Beatrice Cenci."

THURSDAY, MARCH 10...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Ernest Pauer, "The most celebrated Composers for the Piano since 1830."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Edmund Gosse, "The Critics of the Age of Anne." (Lecture III.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Desmond G. Fitz-Gerald, "Reversible Lead Batteries, and their use for Electric Lighting."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MARCH 11...Teachers' Training Society (At the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.

United Service Institute, Whitehall-yard, 3 p.m. Capt. C. P. Fitzgerald, "Mastless Men of War."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. The Ven. Archdeacon Farrar, "Society in the Fourth Century A.D."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. T. Tyler, "Shakspere's Caliban compared with Swift's Yahoos."

SATURDAY, MARCH 12...Physical, Science Schools, South Kensington, S.W., 3 p.m.

Geologists' Association, 2½ p.m. Visit to Natural History Museum, under the direction of D. Woodward.

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Sound." (Lecture III.)

Journal of the Society of Arts.

No. 1,790. Vol. XXXV.

FRIDAY, MARCH 11, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list of subscriptions by members of the Society of Arts to the funds for the Imperial Institute since the list published in the last number of the *Journal*:—

	£	s.	d.
Henry Gurteen Barker	5	5	0
Robert P. Barrow	10	10	0
Mrs. Beare (per P. F. Walker)	0	10	0
Lieut.-Gen. A. C. Cooke, C.B.	2	0	0
G. O. M. Herron	10	10	0
Rev. A. Short	1	1	0
G. A. Thrupp	10	0	0
Amounts previously acknowledged	1,972	17	0
Total	£2,012	13	0

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

RAILWAY BRAKES.

The discussion on Mr. Marshall's paper on "Railway Brakes," at the Ordinary Meeting on Wednesday evening, 9th inst., was adjourned to Monday evening, 14th inst., at eight o'clock.

CANTOR LECTURES.

The last lecture of the course on "Building Materials" was delivered by Mr. W. Y. Dent, F.C.S., F.I.C., on Monday evening, 7th inst., in which the lecturer described asphalt, and dealt with causes that promote the decay of wood, and the methods adopted for its preservation.

A vote of thanks was passed to the lecturer on the motion of the Chairman.

The lectures will be printed in the *Journal* during the summer recess.

UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Young Men's Christian Association, Huddersfield.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1887 early in May next. This medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1886, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemisty, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.. "for the invention and manufacture of instruments of measure and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of

chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michael Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture, have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and a Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communication of North America, and have hereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Mr. Samuel Cunliffe Lister, "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

Proceedings of the Society.

INDIAN SECTION.

Friday, March 4, 1887; Sir JULAND DANVERS, K.C.S.I., Member of the Council, in the chair.

The paper read was—

TRAFFIC ROUTES TO THE EAST.

By MAJOR-GENERAL SIR F. GOLDSMID, K.C.S.I., C.B.

Between nine and ten years ago, I had the honour of reading to a meeting of this Society a paper on the "Existing and Possible Com-

munications between Persia and British India;" between eight and nine years ago, to the members of the Royal United Service Institution a paper on "Communications with British India under Possible Contingencies;" and, less than one year ago, at Manchester, a third paper on "Railways to India from the West." If I now venture to put before you my views on a question more or less immediately treated in three published addresses, it is because I feel that, both in a commercial and political sense, we are about to talk of something which is of permanent importance to our country.

What is here meant by a "Traffic Route" is a means of intercommunication for Great Britain and India, and regions beyond India—but it were better, for to-night, if the range be confined to India only. Reference is made to the transport of passengers, conveyance of goods, and to all carriage by water as by land. I may add, to prevent misconception, that when a particular line of railway is proposed, it is one which has been for the most part thought out, and for a great part visited. Scores of lines may be run through a map connecting appropriate *termini*, but only a few of these will be found in reality feasible. Two routes are selected for examination on the present occasion—that by Egypt and the Red Sea, and that by Syria and the Persian Gulf. These, we may assume, are sufficiently recognised and of sufficient urgency to make all others appear insignificant or secondary. Both begin, as it were, from the Mediterranean; but England is well represented in those parts by Malta and Cyprus, and I see a great future for the latter island in her comparatively new relationship to ourselves. By restricting inquiry to the routes named, I am not supposing that any of my hearers will seriously regard the voyage round the Cape as affording a fitting provision for England's traffic with India. Should I be mistaken, opportunity will no doubt be afforded for the expression of an opinion to that effect, and an endeavour to drive me from my position. As to Colonel Stewart's proposal to join the Russian lines in Afghanistan, the views of so distinguished an authority may not be lightly laid aside; so I propose to say a few words on that subject before concluding my paper.

How, then, are the two chosen links to India secured to us? I may answer, one temporarily by the force of circumstances, the other not at all. The circumstances which have given us control in the valley of the Nile are too well-known to the world to need even a summary, but allusion may be made to their more remarkable features in a brief and very general retrospect. Are you weary of the Egyptian difficulty or of dissertations on the value and political significance of Egypt? In approaching the theme, I will bear in mind the need of more than brevity, and will endeavour to give it the novelty of personal experience. If I speak of what we ought to do, or what we ought to have done, it is not in blame or approval; only in the hope of throwing out, amid much probable chaff, a grain or so of useful suggestion. I cannot pretend to be wise after the event; for the event, according to the latest intelligence, has not yet come off. This is, be it observed, neither the establishment of a Dual Control, nor the bombardment of Alexandria, nor the abolition of the said control, nor the disposal of the Mahdi; but the solution of a late problem which the Anglo-Saxon sphinx should alone achieve; in other words, the re-organisation of the province through which passes the Suez Canal.

Egypt, how full of association is that ancient land! It is the granary of the early Biblical world both in the days of Abraham and of Joseph; it is the abode of the Israelites in the days of Moses, who himself was skilled in its learning, and whose followers looked back with regretful longing to the richness of its more material food. It is the country of Shishak and Pharoah-Necho, who invaded Judah in the reigns of Rehoboam and Josiah, respectively. It is the subject of prophecy to the four greater and to some also of the minor prophets. From Scriptural we pass on to trace its record in profane history, where—irrespective of the twenty-six dynasties of the monuments—we read of conquerors who ruled, and revolutions which disturbed it for nearly 2,000 years after the prophecy of Zechariah, or from Kambyses to Kleber. About the dawn of the present century our own countrymen first appeared on the scene: the spectacle of France and England in open conflict was presented for the edification of Copt, Turk, and Arab; and the abandonment of Egypt by European troops brought about those intestine wars which terminated in the triumph and accession to *quasi*-sovereign sway of Muhammad Ali. But the withdrawal of British and French armaments did not imply that the nations equipping them had withdrawn from all connection with the receding shores. In any case, Great Britain had not done with the Egyptian ruler. That able if unscrupulous warrior had earned a reputation for himself and a position for his

country that stamped him as one of the most remarkable men of the century in which he lived; but he was not to be let alone, because his uncontrolled acts might have injurious effect upon the due balance of power in Europe. The Sultan, at Constantinople, had a claim on the fealty of this Eastern Napoleon, which other nations, and especially England, thought fit to support, and Muhammad Ali was abruptly checked in his conquering career by the same kind of intervention that had been used against the Turk, some thirteen years before, at Navarino. France, however, it will be remembered, was not in this combination.

Of Muhammad Ali's successors, Ibrahim (who reigned only two years), Abbás, and Saïd, the last has earned the distinction of contracting the first Egyptian loan, a public *commitment* or engagement to the Suez Canal Company, entered into in London, though originating in Paris, and stated nominally at something between £3,000,000 and £4,000,000. We are assured on respectable authority that his private debts amounted to more than three times that sum;—but we have reached too nearly our own times to chronicle or criticise the characters and doings of individual khedives and pashas, and, in recalling the fragment of history that remains, must ask leave to omit the names of the principal performers. The reign of the fourth on the list is certainly not the least important. It is one of singular vicissitudes, brought about mainly by personal faults and failings which, in the estimation of many European politicians, were largely compensated for by a spirit of laudable enterprise, a natural *bonhomie*, and an undoubted ability. His people—who had more cause than outsiders to judge him severely—accepted him, as they had accepted his predecessors, with that resignation which, though it give utterance to an occasional groan, is, nevertheless, meek and thorough. But the judgment upon him was that of Europe, and Europe, in the person of her several representatives, offered him tempting loans of money; accommodated him, when he yielded to the temptation, at high rates of interest; sold him her most expensive wares—the outcome of her workshops, yards, and factories—and provided him with choice and costly officials to do his work, or rather, the work she carved out for him; plunged him irretrievably into debt and mortgage; and, finally, deposed and expatriated him. The next step was to nominate a successor; to supply him with the same luxurious *personnel* and *matériel* as before chosen for the administration of his country; and to carry on the approved system until it broke down amid the din and confusion of rebellion. Then the representative nations of Europe differed on the means of checking this untoward movement, and it was left to one only, England, to spend her treasure and shed her blood for the suppression of a military mutiny, merging afterwards into actual war, the scene of which became transformed from the lands of the Delta and Suez Canal to the distant Soudan and shores of the Red Sea. During the busy process, many great and gallant Englishmen gave up their lives to this country, the glory of whose arms was well maintained; but impossibilities cannot be rendered possible by the prowess of individuals or masses. With the disadvantages of hostile surroundings, the rescuing troops could hardly be expected to command success in every expedition or undertaking. Eventually, the noblest of their countrymen fell a sacrifice to his heroism, and the Soudan was lost to Egypt.

Now this dip into a well-known chapter of modern history may appear foreign to the subject of a paper on "Traffic Routes to the East;" but I venture to think that, with a little reflection, you will allow it to be otherwise. My object is to bring before you the question of the Suez Canal; not the nature and mode of its control, and the local regulations regarding its use; not the value of its shares, or the relative monied interests of particular shareholders; not any record of its financial successes and fluctuations; all these are matters, perhaps, better understood in the City of London than in any other part of the world, and on which I would not pretend to throw any new light, or erect any new hypothesis. But I wish to dwell, for a moment, upon the vast importance of this world's thoroughfare to our own country, and on the vital urgency of incurring no risk of letting it slip from our hands, amid the possible contingencies of war or hostile combinations. I wish to emphasise the fact that, whatever view may once have been taken by British statesmen of this simple means of European egress to and ingress from Eastern seas, it is now a universally admitted benefit to the cause of progress and cultivation—a greater boon, moreover, to England than any other nation in the world, as evidenced by the enormous proportions of her ships passing to and fro the Canal compared with those of other nations. And I am quite sure that the little narrative I

have just hinted at, rather than told, or even sketched, is not one from which may be learned the lesson of securing our communication with the East by way of Egypt. All precedent shows that diplomatic success with Oriental potentates and peoples is achieved by a readiness to loose the purse-strings. Egypt, though Africa, is especially the land of *bakhshish*, and quite as much under its influence as any part of Asia. But how have we treated her? Some years ago, in lieu of the lavish expenditure of our own money, an opposite course was pursued; and the result was, failure. That course has been continued and maintained in one notable respect—unavoidably it may be, but, nevertheless, unfortunately. We have been compelled to keep up international obligations in the supervision of the Daira Sanieh, the Domains, the Caisse, and the railways. Under that compulsion we add to the financial ruin of Egypt, and impede the grants of money that would be made for more healthy objects. The three first of the establishments named pay their European commissioners or controllers no less a sum than £21,000 per annum, when the work might be done for £3,000, and well. Moreover, had it not been for this international control, a property like the Daïra might have been shorn of its thousands of profitless acres—I might almost say hundreds of thousands—and reduced to a comparatively compact mass of estates, manageable from a branch of the Office of the Interior. As regards the Caisse, or Treasury, even supposing it necessary to keep up the balance of power by distribution of appointments among certain European States, why should not four, or, if need be, six, of the respective consuls be named *ex-officio* or honorary commissioners, with one paid agent of no fixed nationality to do the actual work? Reflections such as these naturally arise in the minds of men who have resided in modern Egypt, and perhaps held office there, and the retrospect is dark and regretful. On the other hand, putting aside the consideration of bondholders and international obligations, England has, since her military occupation, done much good and honest work, expended money from her own treasury, and given the lives of her best soldiers; and we may well believe that, if ground has been recovered, as there is reason to presume has been the case, the recovery has been of quite recent date.

But what is to be the next move on the political board as regards the interests of the Nile Valley? Rumour is busy in foreshadowing conclusions, and the columns of the daily Press are pregnant with weighty suggestions. The Suez Canal will, in any circumstances, be a subject of earnest care and minute provision, but without the prestige of British soldiery in the land through which it flows, there is no saying what may be its future history. I do not wish to enter too determinedly into the almost forbidden land of political speculation, nor to preconceive a state of things which so many of us would reasonably deplore; but we can hardly do wrong in asking the question—If the British military occupation were to cease, what would be the next best course to pursue to secure our communications with India? So situated, are we to rely solely on the Suez Canal after all that has befallen us in Egypt, and all that has befallen Egypt in relation with ourselves, during these last ten years or more? Or are we to seek for a second string to our bow—some new means of reaching our Indian possessions—not dependent on Egypt at all?

Now, this is a matter for very serious consideration, and of comprehensive bearings. It affects commerce together with politics, individuals together with Governments, Oriental together with European progress, and is, therefore, as appropriate a subject of discussion in a Society for the promotion of arts and civilisation as in the hall of political debate. My humble opinion is that, to meet the hypothesis laid down, there is but one alternative course to pursue, and that is, to secure for our trade and traffic with Eastern seas, the route of the Persian Gulf. That is to say, if we abandon Egypt in deference to the wishes of the Sultan, whom we continue to regard as its lawful lord, then let it be made a condition of such abandonment that a route be provided for us through the Sultan's Asiatic dominions, direct and short, to a point on the upper shores of the Persian Gulf, to supplement, not necessarily to supersede, the older line by the Suez Canal. Most sincerely do I trust that this older line will remain the true line of traffic, as at present; but no doubt must be entertained on the strength of our grip upon it without making provision for an alternative, and there can be no fitting alternative but that here indicated. There was a time when the Euphrates Valley route and proposed railway caused a sensational movement in the minds of politicians and financiers; and there was a time, too, when a company and board of directors would have been the natural result of that movement, but that concessions were not

available in the sense required to win public confidence. In the case now supposed, the undertaking would be that of her Majesty's Government; the concession that of the Sultan to a sovereign power; the line, a line of British railway; the inland protection that of Imperial Turkish troops; the terminal watch being kept by the well-posted sentinel, Cyprus, on the west, and India, with troops and transports in the Persian Gulf, on the east. The prospect is not discouraging; only the Suez Canal, with Egypt as at present, is a more pleasing picture.

In now putting before you a projected railway, first to the shipping in the Persian Gulf, afterwards in its extension to India itself, I shall be going over old ground; but as I have not the vanity to believe my views are known to many of my present hearers, I may repeat much that I have said before without incurring the odium of inflicting upon you a twice-told tale.

Supposing that we had to make, as rapidly as may be, an alternative line to that across Egypt. For this purpose I would recommend simultaneous work westward from Karachi, along the Makran coast to Jashk, a telegraph station manned by our own *employés*, distant, roughly, 700 miles; and eastward from a starting point near Cyprus—Ruad or Tripoli—to Kuwait, or more convenient spot in the vicinity, at the head of the Persian Gulf, distant, say 850 miles. There would remain 600 miles or so by steamer from the last-named point to Jashk. The whole distance would be about 2,150 miles, to be accomplished by rail and steamer in some six days and a-half.

This, let us bear in mind, is merely a suggested means of communication of some practical kind. It might serve for an emergency, or as a temporary arrangement, but it could not be wholly satisfactory, and would be positively defective and inconvenient if, by mischance, the Egyptian route were not available. Looked upon as a preliminary to a great land line from the shores of the Mediterranean to India, it would run a fairer chance of favourable acceptance. Here, then, we are brought face to face with a project of unusual magnitude, but the result would be well worth the trouble of its consideration, the labour of its construction, the negotiations which it would involve, and, I cannot but think, the money outlay which must inevitably attend its execution.

There is no time to travel back to the great lines of traffic which in ancient times passed from distant Oriental cities westward through Syria to the Mediterranean; Tadmor, Nineveh, and Babylon must be left to their past glories, though the site of the first may be found suggestive of revival. We read, however, of an old high road from Tangiers to the borders of China which, in its Asiatic section, is significant of a modern railway. Baghdad, Ahwaz, the Province of Fars, Karmán, and Sind, names to which I shall shortly recur, are all upon the road in question. If ever constructed, the so-called preliminary line would be diverted at some carefully selected point, so as to enter as a main line the south-western district of Persia, and find its way to Shiraz. If not constructed, the above line would represent a permanent line entering directly into Persia, without seeking the shores of the Gulf at all. Undoubtedly there would be great physical obstacles to be encountered in this section, but not, I have reason to think, insurmountable. As to the section east of Shiraz, a recent journey from that city to Jashk, the port above-mentioned, has convinced Mr. Preece, an able officer of the Persian Telegraph, that if the question of a railway through Persia near the sea-board take at any time substantive form, a careful survey of the route from Shiraz to Bandar Abbas through Darab and Forg, would repay the projectors. The engineering difficulties are stated to be nearly *nil.* The line would tap a large grain-growing country, easy of access to the merchants of Yezd and Karman; and at or near Bandar Abbas a convenient and sheltered roadstead could be found which would soon become a resort for shipping in preference to that at Bushahr. This report is indeed satisfactory, because the want of a generally fertile soil has been felt as a main objection to projected Persian railways, to run along the north, centre, or south of the kingdom. Moreover, from Jashk along the coast to Karachi, although there is little fertility to rejoice in, the country is such that the rails could be laid nearly in accordance with the telegraph line. For the greater part of this latter section I can speak from personal experience, derived in the course of two political missions—the first of which involved an inspection of some 400 miles in Makran, over ground selected for setting up the telegraph posts and wires.

When the present scheme was put forward in 1878, it was naturally met by several objections, both in the Press and in a less public manner. In reverting to these, you will, I trust, pardon me for here repeating my replies to the two more important, namely, that the

cost would far exceed the possible returns, and that as the railway would pass through the territory of a foreign state, it could be neither safer nor more convenient than a canal which had been excavated and was used under similar conditions.

I wrote "that the railway would not pay, I can only admit, in the sense of immediate money returns. Eventual success as a source of revenue is, to my mind, as certain as the healthy influence to be exercised by the locomotive among the Iliuts, or nomad tribes. But the opinion of the Select Committee of the House of Commons, appointed to consider the question of the Euphrates Valley line, is assuredly pertinent evidence on this head. If otherwise, why appoint advisers and judges at all? They expressed their belief that the two routes by the Red Sea and by the Persian Gulf might be maintained and used simultaneously; that at certain seasons the advantage would lie with the one, and at other seasons and for other purposes it would lie with the other; that it may fairly be expected that in process of time traffic enough for the support of both would develop itself, but this result must not be expected too soon." For more arguments under this head I must refer you to the April, May, and June number of the *Manchester Geographical Society*, reporting my last year's address. I took, however, occasion to point out that the whole line advocated from Cyprus to Karachi was only a feeder, or an outlet of the Constantinople-Baghdad line (awaiting means and opportunity for construction, though worthy of consideration at any time as an essential route of the future), its junction with which would necessarily add immensely to its money value.

With reference to the objection on the score of insecurity, owing to geographical position, I continued to quote the opinion of the Select Committee that "the political and commercial advantages of establishing a second route would at any time be considerable, and might, under possible circumstances, be exceedingly great; and that it would be worth the while of the English Government to make an effort to secure them, considering the moderate pecuniary risk they would incur." To this quotation I added the following remarks:—"Who that has attentively watched the changes of the few years which have elapsed since publication of the papers comprising the bulky Blue-book of the patient Euphrates Valley tribunal, will not admit that if the opinion then expressed by its members was justified by the circumstances of the day, it is not more than justified under the present aspect of affairs? . . . . At present, England's use of the Suez Canal is a main cause of substantial profit to shareholders of many nationalities; but neither doubling its breadth, nor duplicating it by a new cutting, would insure it as a permanent passage to English ships, if this country were isolated from other European nations. Treaties and agreements have limits in circumstances, and as they are born of certain phases in the political world, so must they become obsolete and die under conditions of an opposite kind. But even if the Suez Canal were our own national property, and we were to shut our eyes to considerations of politics and strategy, why should we not arrange in peaceable negotiations with the Ottoman Government for a line of railway which would carry us to the Persian Gulf, as did the Alexandria-Cairo and Cairo-Suez Railway to the Red Sea before completion of the Canal cut by M. de Lesseps, against the wishes, but somehow for the especial use and advantage, of the mercantile English nation." *

The above was written about a year ago, when the situation was not quite what it is at present. In stating the case to-night, I make direct reference to the question already proposed: "If the British military occupation were to cease, what would be the next best course to pursue to secure communication with India?" My counsel would be briefly this: To secure, upon the best possible conditions, a line of railway by the Euphrates Valley to the Persian Gulf; or, if need be, to a point in Khuzistan, South-Western Persia, whence it could pass by Shiraz and the Makran coast to Karachi in India. Karachi, I need scarcely explain, would, in such circumstances, acquire increasing importance. But it is worthy of the honour, and possesses many local advantages for becoming the terminus of a Western railway system. The far-seeing Commissioner in Sind, Sir Bartle Frere—whose name will ever invoke respect and regard—did much to bring into prominence this part of Western India and maritime capital of Sind.

I do not say that a complete Cyprus-Karachi line, such as that sketched out, would not admit of many modifications on survey and construction, especially in the more westerly section which I now distinguish by the names Tripoli, Palmyra, Baghdad; and again in the west-central section, for which I select the

* For these quotations see my address to the Manchester Geographical Society in the second Quarterly Journal of 1886

points Shustar, or Dizful, the Ram Hormuz plain, and Shiraz. But these indications are ample to give a notion of the general direction contemplated, and the geography of the remaining link may be made intelligible by the names Forg, Bandar Abbas, Jashk, Gwádar, Ormára, and Sonmiàni. The main doubt I have is how to reach Shiraz, for it would be a thousand pities to exclude that city from the system of Persian railways, and resort to the barren and dreary coast. If that end were not to be attained by engineering skill, I should prefer a course by Ispahan, Yazd, and Karman, and thence through the most practicable pass from the Bampur plain to the coast of Makran. What I would now wish is that attention be given to the proposal in its entirety, and I believe that its execution would be found not only practicable but highly desirable.

But, independently of any arrangements to be made with the Porte, there are special political considerations in connection with this line, which seem to merit more than passing notice. In the first place, it would necessitate an understanding with the Shah of Persia, whose consent would have to be obtained by means which, whatever their nature, would bring us into closer and more intimate relations with that important country. By the Conventions of 1862 and 1865, his Majesty admitted at our instance the lines of telegraph into his dominions. That he has had no reason to regret the concession may be clearly proved by the open regard he has ever shown, and continues to show, to the British officers of Engineers employed in the construction, organisation, and supervision of the aforesaid lines. Only within the last year or two he presented a sword of honour to the Chief Director, my lamented friend, Sir John Bateman-Champain, who has so recently passed away from among us; and were Colonel Murdoch Smith, the Director of the special Indo-Persian lines, not now in England, I could say much in testimony of the extraordinary value of his services, and their appreciation by the Persian Government during a period of about a quarter of a century. I have no hesitation in saying that officers such as these, and others whom I could readily name, their colleagues in constructing and establishing the Indo-European telegraph—men who know how and when to use conciliation, how and when to exercise firmness, always loyal to their own Government as well as to that of the land of their official sojourn, always honourable gentlemen, and hard-working and capable servants of the State—men such as these pave the way to fresh concessions in our favour by example and conduct more substantially and directly than conventional diplomatists, however skilled and experienced. I am sure that in this expression of opinion I am indulging in no irrelevant sentiment or extravagance, and that the representatives of our Government at Teheran would themselves bear similar testimony to the worth of their countrymen employed in the telegraph service. Thus, then, one material difficulty in the way of obtaining a concession for a railway—the sanction to a new influx of European officials—would have been smoothed over. Indeed, there is no reason why one or more of the higher telegraph officials in Persia should not be employed in organising the railway, as they were in the preceding work. Had we now been assembled within an area of political discussion, I might have enlarged upon the propriety of alliances with this or that country; but it will suffice for the occasion to remind my hearers that, if Persia was an acknowledged factor in our diplomacy at the commencement of the present century, and in 1839, it has every cause to be considered so in 1887. Perhaps our predecessors were wrong. I do not think they were; and they had foresight for future contingencies as well as wisdom sufficient for the day.

Secondly, its proximity to the seaboard of Baluchistan would not only make it accessible for the transport of stores by sea, but also facilitate sumultaneous land and sea movemants in case of emergencies.

Thirdly and lastly, it would be independent of all lines already constructed or under construction, which would tempt us to trust our Indo-European traffic to the great semi-European and semi-Asiatic nation overhanging Persia and Afghanistan on the north. And now I seem to have reached the particular question on which I am at issue with my friend Colonel Stewart. That gallant officer and adventurous traveller, than whom no one has better warrant to advance an opinion on matters of this nature, and from whose judgment I am very loth to dissent, has stated, in a paper read before the London Chamber of Commerce less than three months ago, that we should use our best endeavours to connect Quetta with Herat by rail, and join Herat with the Russian line intended to connect the Eastern shores of the Caspian with Samarkand. To this proposal I must strongly

lemur. There is plenty of time to think about railways in Afghanistan; and there certainly are valid reasons why Indian communications should not be dependent on the goodwill and friendship of Russia, however well-disposed we may feel towards her in ordinary relations.

Before concluding the present paper, I venture to repeat, with a few modifications, two more paragraphs from my Manchester address:—"What is it that Russia seeks in her advances to the Far East, and more especially to the South of Central Asia? Nine politicians out of ten will say that she must have an outlet to the sea for her newly-acquired commercial resources; and let us presume that this is so. Either, then, she must have what she seeks, or she must remain in a constant state of morbid irritation towards those who prevent attainment of her ends. Is it better that she should be thwarted and thwarted, or shall we endeavour to gratify her wishes with the least possible injury to our own particular prestige and commerce, and with the greatest possible benefit to the world at large? The question is hardly, in my humble opinion, to be answered by the proposal to give her a ready way through Afghanistan into India;" but rather by a suggestion, the novelty of which may make it appear to many eccentric and absurd. Could we meet the Russian emergency by laying down a line, not, as Colonel Stewart suggests, from Herat to Maruchak—100 or 120 miles—but by combining with her and other nations concerned to open communication with a port on the Makran coast? This contemplates a long line along the Hari Rud and Perso-Afghan frontier, inclining eastward to the Lower Helmund, and from the elbow of the Lower Helmund near Rudbar, running nearly due south to the sea.

"I could mention two or three appropriate places between Bandar Abbas and Gwadar, which might be reached in a line of some 600 miles, more or less direct, from a point eastward of Sarakhs. Such a line might be strictly 'international,' so far as the nations interested in its welfare are concerned—England, Russia, Persia, Afghanistan, and Baluchistan, and the conditions of its use might be determined by a convention or agreement of five parties. The two nations first named would be the constructors, the three last named the guardians from north to south. It may be inferred that the country more immediately interested would find the bulk of capital needed for the undertaking, but it were premature to touch upon this point in the first stage of a mere suggestion. The fact of preserving an independent outlet to the sea should commend itself to a nation that would otherwise be driven to rest satisfied with the privilege of passing its goods and general traffic into the dominions of a rival power. And there would be no bar to this latter procedure, if preferred, for the Makran coast line would be the channel of communication with British India in the event of diversion of traffic to that quarter.

"But another great object might be gained by thus opening a direct communication with the sea from the country between the rivers Hari Rud and Murgháb (which we may almost call the Russo-Afghan Mesopotamia), and to this object British India should not be indifferent. The line could be so drawn as to indicate a frontier between Persia and Afghanistan on the north, and Persia and Baluchistan on the south. To make my meaning clearer, I suggest as a starting point the right bank of the Hari Rud, following that river up to about Kuhsan, whence the route across the desert country would bring it to the left bank of the Helmand, and close to the termination of the Perso-Afghan frontier—a fair enough half in reality, perhaps a little in excess of five degrees. The second half would divide Persian Baluchistan from independent Baluchistan, over tracts in extent perhaps somewhat less than five degrees. It would require no intricate negotiation to make this railway demarcation chime in with previous arrangements in settling local boundaries to which England has been the most important party. A strongly defined frontier of the kind—that is, a frontier without our own frontier—would be a double security to any more immediate frontier which yet remains to be drawn out upon strategical or other scientific principles; and the recent surveys of a detachment from the present frontier commission, added to my own personal observations, and those of the engineers and other officers serving with me—and, notably, a separate reconnaissance by the late Sir Charles Macgregor, an officer who has done much to explain the true geography of these little-cared-for countries—all these would prepare the way to a speedy understanding on the actual track to be followed.

"Plainly and briefly, there would be little trouble to the initiated to lay down a line of frontier from west of Herat to the sea, which might be made absolute, as it were, by an international railway, providing, in its continuous neutrality, both a reasonable guarantee against

encroachment and an infallible testimony to acknowledged possession on either side. Such an achievement might be made a means of civilising the predatory tribes, whether Afghan or Baluch, by offering them employment as guardians of the line, or as cultivators, to supply the wants of these guardians out of the produce of the soil."

One word more, and I have done. A scheme has been put before you which will have, as it has already had, many opponents. Among these will, doubtless, be found advocates of that north of Persia line, in which not the least important section is from Teheran to Herat *viâ* Mash-had. But I would ask you, when discussing the merits of the several lines proposed, to remember that the Cyprus-Karachi route has at this particular time been put forward only as an alternative to the Alexandria-Bombay division of the so-called overland traffic route of to-day; and that it is the possible offer of *a golden opportunity for securing a satisfactory concession for this alternative* which prompts me to bring up the subject at all.

DISCUSSION.

Captain CAMERON said General Goldsmid spoke with an authority on the subject of which he had treated which few had a right to claim; but on one point he thought he had fallen into an error, in common with almost every one else, viz., as to the Suez Canal being a benefit to this country. There was no doubt that the Canal having been made, it was essential that England should maintain control over it; but it had done us a great deal of harm in taking away much of the entrepôt trade which came to England when the only route to India was by way of the Cape, but which now went to Trieste, and other ports not English. If a war occurred, most of the steamers which used the Canal would be almost helpless, and it would require at least thirty first-class cruisers to convoy them through the Mediterranean; and even then if other nations were interested in destroying our commerce, they could send out torpedo boats from Algiers, Sicily, and other places, and very easily destroy the steamers carrying the trade through the Canal. He agreed with nearly all that had been said about the railways. He was particularly attracted by the suggestion to carry a line from Herat down to the Persian Gulf, and so give Russia an opening to the sea; and he fancied Russia was already working in that direction, as they had lately established at Mosul a consulate, and besides the Consul there were several assistants, as at Erzeroum, where before the last war, the consular staff surveyed all the strategic points of the country. Russia was working to get hold of the Persian Gulf, and was looking to it even more than to India, and it was therefore especially necessary that England should have control of the Persian line. It would be a great advantage to have a communication with Shiraz, if it could be effected without any great engineering difficulties; but it lay at a very great elevation above the sea. So far as he could learn, a line through Faristan could be carried for long distances on high level shelves, with only occasional breaks—like the Ghauts in India—which would have to be crossed, so that the greater portion would entail very little difficulty. But as for English trade going north, he did not think it would go a yard beyond the Russian frontier, for the Russian custom-houses were only meant to prohibit the passage of foreign goods. As Mr. Marvin had shown, all the Bokhara trade, to the amount of £80,000 or £90,000, which used to go through British India, had now been taken away by Russian influence. That was rather an objection to Colonel Stewart's plan. An article in the *St. James's Gazette* that evening showed how the Russians had pushed forward to Merv, even across the sandy deserts, and how our great commercial rival was in every way seeking to get hold of the routes to the sea. He thought the terminus of the first line to be made should be in the Bay of Tripoli; there was a pass between the Lebanon and the mountains to the north, through which the old Roman road went, and the oldest historic road in the world used to run. His own idea, based on personal knowledge, was to first make a line to Homs, connecting with one between Aleppo and Damascus, to intercept all the traffic, and then carrying a line at the north end, and going straight across to Mosul, not direct to Bagdad, because there was so much desert there, whereas on the route he recommended it was a fertile country. On the Syrian coast there was ample traffic to pay 10 per cent., after making large allowances for commissions and every expense. From Mosul he should prefer the right bank of the Tigris, where the engineering difficulties would be much less than on the left or eastern bank, on which were the two Zabs, which the Arabs called "wicked streams." At Bagdad, instead of following the doab between the Tigris and the Euphrates, he should cross the river below Bagdad. In the doab there were numerous marshes, owing to the destruction of the old canals, and at Kuwait, where the line was proposed to terminate, there was no fresh water within a distance of some twenty miles. If you crossed the river at Bagdad, you came to a fairly open plain, where there were rivers which would be available for carrying materials for some distance, and at Dilam there was a very good port. These were all simple questions of detail. With regard to the line which Sir Macdonald Stephenson had tried to make, he had joined the committee, as he believed all lines would do good. When Batoum was opened as a free port, the English merchants who used to trade with Persia by way of Trebizond and Erzeroum adopted that route,

but now the Russian customs had blocked that route and cut off the English trade, Batoum being no longer a free port, and now Russian goods coming down by railway and the Caspian to near Teheran, were supplied to the Persians, though they were dearer than the English, and inferior in quality. Any mode by which communication between Persia and the Mediterranean could be made cheap and easy, to save the difficult navigation of the Black Sea and the Archipelego, would be an advantage, and, of course, so long as England maintained her present naval position, she would have the lion's share of the carriage.

Colonel MURDOCH SMITH said he could not throw much light on this subject, but he agreed with almost very word which had been said by Sir Frederick Goldsmid and Captain Cameron, partly with the somewhat paradoxical opinion, stated by the latter, that the Suez Canal was a great misfortune to this country. But it was no use crying over spilt milk; the Canal was made, and they must make the best of it, and endeavour to keep it open. Our ships, now-a-days, were built specially for the Canal traffic, and if a torpedo were exploded in the Canal, or a ship were sunk in it so that the traffic were stopped, a great mass of our ships would be utterly useless for the Indian trade. The first lesson taught by the paper was to pay proper attention to the naval part of the question, and keep up a type of vessels suitable for going back to our old route by the Cape, which was entirely within our own control. There were four main routes to the East; (1) by the Cape, (2) by the Canal and Red Sea, (3) by the Persian Gulf, and (4) by the Black Sea and Caspian. These varied greatly, from the first which was entirely within our own control, to the fourth, which was entirely beyond our control, and for that reason he agreed with what Sir Frederick Goldsmid had said with regard to Colonel Stewart's scheme. The further south the line lay, the more it was under our own control; but, unfortunately, the Suez Canal route was very precarious, and, therefore, we ought to look to the third route by the Persian Gulf, which was the only practicable alternative. It seemed to him the best mode of procedure was to develop what already existed rather than suddenly to take a new departure. The trade of the Persian Gulf, when he first went there twenty-four years ago, was represented by a small steamer which came once in six weeks from Bombay; but by the very excellent management of the British India Steam Navigation Company, that trade had enormously developed, until the steamer came monthly, then fortnightly, and then weekly, besides many other vessels which came at more or less regular intervals. The first thing to be done was to secure the trade we already had there, and to understand that, it was necessary to go back a little. Some years ago the main route was by Trebizond, Erzeroum, Tabriz, and so into Persia, but when the Russians increased the number of their steamers on the Caspian, especially after the development of the naphtha works at Baku, by making the railway from Poti to Tiflis, a good deal of the trade that used to go by Erzeroum went by the Tiflis and Caspian route, which at that time was free of duty. Then came the war between Russia and Turkey, which disorganised both those routes, and the result was that most of the trade went round by the Persian Gulf and Bagdad. When the war was over, the Russians immediately turned their attention to railways again, and completed the line between the Black Sea and the Caspian, from Baku at one end to Batoum at the other. Immediately that was done, the custom-house system was introduced, and all foreign goods were practically prohibited. Meanwhile, the other route, by Trebizond, had been practically abolished, so that now, in the north of Persia, Russian goods were brought at a far cheaper rate than English goods could be through the Persian Gulf. Everything, therefore, should be done to develop the trade by the Persian Gulf. One important point would be the opening of the Tigris to free navigation. At present, the Turkish Government only allowed two English steamers on that river, whereas ten or twelve would be none too many. Then the River Karoun, in Persian territory, ought to be opened up to navigation, and a railway carried from some point upon it to the interior of Persia, from whence branch lines could be carried all over the central plateau with the greatest ease, and at very little cost. We should thereby have complete control of the trade, and with it should retain political influence.

Mr. T. H. THORNTON, C.S.I., said he heartily agreed with anything that tended to develop trade and open up communications. Whether, however, it was desirable for the British Government to spend large sums of money in developing railways that would not pay beyond its own territories, was a question upon which he was not quite clear. Neither did he agree with Sir Frederick Goldsmid as to the advantages likely to follow from the opening out of a railway from Herat down to the Persian coast. Speaking with the greatest deference, he was inclined to think that a railway undertaking based upon a quintupartite convention, which he felt pretty certain not four out of five of the parties would adhere to, was not a very promising speculation. In his judgment, much as he sympathised with everything that promoted commerce and developed intercourse between nations, he thought every shilling spent in developing communications within our own borders, and improving our strategic position there, was, as far as the protection of India went, worth 10s. spent in the construction of railways in Asiatic countries beyond our own frontiers. He thought preceding speakers had taken too gloomy a view of the situation with reference to the Suez Canal. They had been told that if the Canal were closed by a torpedo, or anything of that kind, we should be in dire distress for want of vessels suitable to carry on

the trade by other routes. He had the misfortune to hold shares in several great steam-shipping companies which had a large number of ocean-going steamers, some of which were now laid up, and if the Suez Canal were closed, they would be in a position at a moment's notice to take an enormous amount of merchandise by the Cape route to India.

Mr. MARTIN WOOD thought the last speaker had put forward one view which was much needed in this discussion. With regard to the alternative route to the Suez Canal, which Sir Frederick Goldsmid had called the Cyprus route, it was a variation of the old Euphrates Valley route, and there could be no objection to it beyond its own inherent difficulties, which must always attach to a long railway through an arid unproductive country. That was a necessary part of any scheme for getting from the Mediterranean to the Persian Gulf, but he did not see why that should be complicated by adding another long piece of line along the Mekran coast. Having got to the head of the Persian Gulf, either Bombay or Karachi could easily be reached by water. With regard to General Goldsmid's proposal for a line from Merv down to the Arabian Sea, he quite understood his feeling it needful to apologise for such an unusual proposition, but if it were carefully examined, he thought there were many elements in it sufficient to command respect. It had this merit, that it would directly serve its object—viz., to connect the interior with the sea. He did not quite understand what part the railway into Persia had in Sir Frederick Goldsmid's own scheme across the Euphrates valley, because that was not a necessary part of the road to the Gulf. Proposals for railways in Persia were very good in themselves if left to depend on their own merits, but he did not see why they should be mixed up with plans for a direct route to the East. He thought the rumours one continually heard about the precarious character of the Canal route were much exaggerated; of course, it was only a ditch, but it was a very fine ditch, and there was this guarantee of its security, that all European nations were interested in its preservation. When war time came, those who were specially interested would have to take precautions. He could not undertake to follow the political aspect of the question, but he would remind them that the safe passage of the Canal had never been endangered by the Egyptians themselves, either by the Khedive or the National party, as it was called, and it was never in any danger until our own officers made it the basis of military operations. It was often proposed to put the Canal under an international guarantee, and no doubt all nations were interested in it; but as there would be great difficulties in making such arrangement, it seemed to him the best course would be to stand on the old lines, and recognising that the Canal was in Egypt, under the sway of the Turkish Empire, look to the local political powers for its preservation. He could bear testimony to the high esteem in which English officers were held by the Persian Government, and, might add, to the regrets which had been expressed over and over again at the woful mistake which was made when our political intercourse with Persia was transferred from the Indian Government to the Foreign Office. He almost despaired of seeing that arrangement again changed; but he did not quite, as Sir Frederick Goldsmid's remarks with regard to the remarkable influence which followed the exertions of the telegraph engineers in Persia seemed to point to the possibility of some change in that direction again.

Mr. HYDE CLARKE had listened with great interest to this paper, both from having known the author so many years, and being aware of his knowledge of the subject, and also from having a personal interest in it. Sir Frederick Goldsmid had most fairly stated the case, and while putting forward his own views, had been most careful not to put others out of sight, or in any way to come into unfair antagonism with them. With regard to Egypt, he regretted to say that he entertained the same opinion as to the course we had pursued. He had had a share in many of the negotiations with regard to the bondholders' interests, and he agreed completely with the views Sir Frederick Goldsmid had put forward. The whole course of our proceedings in Egypt, whether political or financial, had been injurious to our own interests, and detrimental to those of Egypt; but, unfortunately, it was no use going back on the past. Coming to the main topic of the paper, he would refer for a moment to the plans proposed by Sir Macdonald Stephenson, of which Captain Cameron had spoken, for a line through Asia Minor. He had brought forward that plan more than once in that room, as for twenty-five years from 1859 he represented that line, and exerted himself to carry it forward, and it must not be considered as hopeless. They knew the Ottoman Government were subject to great embarrassment through financial difficulties, but at the same time it was not beyond its compass to carry out a considerable part of that line. They were not so destitute of financial resources as was supposed. He did not mean that they had funds in their own hands, but they had resources which could be turned to financial account, which would be applied whenever proper arrangements were made for them. At present Mr. Pressel was laying before them a plan for carrying forward the route in Asia Minor, which would be carried out with Turkish resources as a basis for European financiers. The real difficulties, with regard to this undertaking, had been that Englishmen had gone to the Turkish Government asking them to do things purely for English purposes, without any reference to the requirements of the Turkish Government itself. In the next place, the Turkish Government, unfortunately, in its railway management had followed the French practice instead of the American and the English. They had had some experience too, the

ıest of their railways having been made by English ompanies, whilst the other part of their system, vith which they had had most trouble, was made ınder the French plan. At the present moment hey were acting as if they could be choosers in the natter, whereas really they had to ask the favour of the financial public; they were demanding that a large amount should be paid as caution money on this concession of Mr. Pressel, while, at the same time, they required that first-rate financial houses should engage in the undertaking. No financial house was prepared to lodge a large sum in the hands of the Ottoman Government, instead of employing it in commencing the undertaking. If our Government and the authorities at the India-office would take this matter in hand seriously, in the interest of the two countries, there would be no difficulty financially, for most of the resources required were to be found on the spot. He could state this from personal knowledge acquired in the country. That project, therefore, of the northern line would go on by itself, and would ultimately combine with the shorter and, as Sir Frederick Goldsmid called it, temporary undertaking from the Mediterranean. It was quite true that about twenty-five years had been wasted, but, nevertheless, the lines would advance in Europe, and in a short time, unless political difficulties intervened, they would get a line to Salonica which would give a great impulse to the Mediterranean line through Syria to the Persian Gulf. In the last quarter of a century engineering had made great progress, and the power of the locomotive had been increased so that the once difficult gradients had now become easy. The cost of materials also had been greatly reduced. As to the Russian lines, either that of Colonel Stewart or Sir Frederick Goldsmid, he was rather inclined to support a different route. Colonel Stewart was desirous of getting access to India in that way, and Sir Frederick Goldsmid would satisfy what he considered the natural desire of the Russians to get to the sea. The result would be that we should supply passengers to pay the Russians for their railway system; we should get no trade by that route, because our trade with Russia was cut off; in effect, we should be paying the Russians a revenue from our passengers and our goods in transit through Russia. The Russians had no legitimate commercial desire to satisfy, only a political and an aggressive one, and it became a question whether there was any duty incumbent on England to satisfy Russia for such a purpose; was it not rather an indication that we should not assist our good friends in any such purpose? If we employed our means in feeding such a railway, we took away those resources which would really feed the lines of which Sir Frederick Goldsmid had spoken. A long course of examination had satisfied him and others that there were means of revenue on these lines, that they were not of the expensive nature supposed, and were capable of soon being made reproductive. He would conclude by expressing his thanks to Sir Frederick Goldsmid for having brought to bear on this important subject the weight of his knowledge and experience; it was one which had been kept back mainly by ignorance, and it was important that it should be pressed on the attention of statesmen and the public as often as convenient.

Sir F. GOLDSMID, in reply, said he would only refer to two of the points which had been mentioned in the discussion. Whatever might be his own views as to the original value of the Suez Canal to England, it was now an accomplished fact: it was the accepted thoroughfare of European nations, and the question was, how to deal with a route on such serious conditions. With regard to the other question, he might say plainly that he did not expect the majority of his auditors to accept his proposal for a line from Central Asia, or the country about the Hari Rud, Herat, and Merv down to the sea, and what Mr. Thornton had said was just what he expected to hear. At the same time, to explain the matter thoroughly would take more time than was at his disposal. The idea did not come to him from reading books or asking men's opinions, but from his own presence in that region on two occasions. He felt a very great interest in that part of the country, for though undoubtedly a frightful desert, it was, to him, an interesting desert, and the people were interesting also. Although, as Mr. Thornton had said, the first duty of England was to look at home, and care for her more immediate subjects, still her greatness had not been obtained solely by attention to her own people or her own country. Having done our duty to India itself, we might spare a little time for those in the neighbourhood outside the frontier who looked to us for guidance and help, and whose well-being would react favourably upon our own people in India, because one had immediate relations with the other, relations which should be encouraged and fostered.

The CHAIRMAN, in proposing a vote of thanks to Sir Frederick Goldsmid, said that the discussion had shown a consensus of opinion in favour of maintaining and improving our communications with India. That was an object which he hoped the Society of Arts would always keep in view and endeavour to promote. Those communications were vital, not only to India itself, but to this country, and whether we looked on the old Cape route as one which was not to be abandoned, or on the Suez Canal route as one which should be maintained at all hazards, one or other of the new enterprises which had been so well brought forward ought before now to have been worked out. They could all see the necessity to both India and England of maintaining not only one, two, or three, but perhaps four different routes to India. Very recently a fifth route had been suggested, which in certain contingencies would be an advantage, viz., through America by the Canadian Pacific Railway. All these routes should be kept in view. The

curious thing was that, considering the many years for which the Euphrates Valley and the Persian Gulf route had been considered of such importance by people in this country, by Parliamentary Committees, and by influential members of different governments, nothing had as yet been done. Why was this? He feared it was the old story. Want of money was at the bottom of it. Political difficulties might be overcome, and engineering difficulties they all knew could easily be surmounted; but the money question still stopped the way, and prevented any progress being made. He was glad to hear from Mr. Hyde Clarke that the resources of Turkey, which were unbounded if properly managed, could be so applied as to make them available for raising money for this object, which would be a most important addition to its natural resources. Nothing would do more to promote the prosperity of that country, and to increase its civilisation and trade, than a railway through its territory, and when this was joined with others to Persia and India, its value would be very greatly enhanced. He feared, however, that, at present, nothing short of a joint guarantee from the British and Turkish Governments would induce capitalists to raise the necessary funds for the purpose.

The vote of thanks was carried unanimously.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 9th, 1887; Sir FREDERICK BRAMWELL, D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Harris, George David, 32, Inverness-terrace, W.
Jarvis, John Edmund, 39, Victoria-road, Kensington, W.
Kell, Robert, St. George's Club, Hanover-square, W.
Lee, Henry Austen, Foreign-office, S.W.
Lile, John Henry, Devon-house, Brixton-hill, S.W.
Paget, George Edmund, M.A., 3, Sutherland-terrace, Westbourne-park, W.
Rickatson, William Henry, 6, Ridinghouse-street, Langham-place, W.

The following candidates were balloted for and duly elected members of the Society.

Barriball, W. T. H., 2, Corbyn-street, Hornsey-rd, N.
Evans, Robert, South-road, The Park, Nottingham.
Hewitt, James Francis, Devoke-lodge, Walton-on-Thames.
Puleston, John Henry, M.P., 7, Dean's-yard, Westminster, S.W.
Scorer, Alfred George, Abercorn-lodge, Upper Hamilton-terrace, N.W.

The paper read was—

RAILWAY BRAKES.

By WILLIAM P. MARSHALL, M.Inst.C.E.

I have been asked to give this paper on "Railway Brakes" from an independent point of view, as an old railway man not now connected with the working of any line, and entirely unconnected with the various inventors of brake apparatus whose work has to be examined and discussed in the consideration of the subject, the object of the paper being solely to ascertain the means of obtaining the highest degree of efficiency and safety in railway travelling. In this view, railway brakes occupy a very important position, and on their perfection and certainty of action is dependent the safety of running express trains at high speeds and for long distances, without station stops, but with the liability of being suddenly and unexpectedly pulled up for obstructions on the line; also the saving of time with stopping trains, by shortening the interval required for pulling up at each stop; and also the safe working of the long steep inclines that are now numerous in other countries, and are laid out with much steeper gradients than were formerly in general use.

The importance of the question of railway brakes has been greatly increased in late years, in consequence of the great increase that has taken place in the weight and speed of trains, the great increase in the number of trains run upon the same line, and the extensive adoption of quick through trains running long distances without stopping, and having to pass many stations and junctions during those runs. Taking an increase of only three times in the weight of trains, and one and a-half times in the speed of running, the brake-power now required to stop the train, being in the proportion of the square of the speed, is more than six times as great as in the earlier days of railway working. In those days the only power for stopping the train, besides the engine and the tender brake, was the brake power of a single guard's van; which was afterwards increased to two or more guards' vans as the trains became increased in size.

Simple Brakes.—The first brakes had only a single brake block, acting upon one wheel only of each vehicle; these were then doubled, acting upon one wheel in each pair of wheels, and then doubled again, acting upon both wheels in each pair, for the purpose of avoiding the torsional strain put upon the axle when the brake is applied to one wheel only of the pair upon an axle. Finally, the brake

blocks were again doubled, acting upon both sides of each wheel, as shown in Figs. 1, 2, and 3 (p. 416), by which arrangement the pressures of the two brakes on each wheel are made to balance one another, thus relieving the axle from all strain of the brakes, and leaving it nearly as free to play up and down in the axle-guard with the action of the springs, when the brake is on as when it is off; whereas, when the brake-blocks are on one side only of the wheels, the whole thrust of the brakes is received by the axle and axle-guards, which checks the action of the springs, and causes unpleasant jarring in the carriage.

Compound Brakes.—The simplest form of hand brake actuated by a lever can only be put on by a man standing on the ground alongside the vehicle. In order to put on the brake from the train, the brake lever is actuated by a screw upon a vertical shaft that is turned by the guard inside the vehicle; or the lever is pulled by a chain that is wound by the guard upon a vertical shaft, like the ordinary tram-car brakes. Then, by connecting this chain with the corresponding one of the next vehicle, one brake handle can be made to put on the brakes in more than one vehicle; but the hand power of the brakesman would not be sufficient to put on all these brakes with sufficient pressure to make them effective. For this purpose the winding power of one of the axles of the brake-van is taken advantage of by means of a friction roller that can be put into action when desired by the brakesman. This forms what is known as the *Chain Brake*, used on some railways, and shown in the diagram (Fig. 1). A cylindrical roller is fixed upon the axle of the wheels, and a second corresponding roller is fixed on a separate swinging shaft, upon which shaft the brake chain is wound. The swinging roller can be pressed against the first one by the brakesman, by means of a vertical screw and lever, and it is then made to rotate by friction, and winds up the brake chain, and so puts on the brakes with a pressure regulated by the hand power exerted at the brake shaft to press the friction rollers together. Double friction rollers are shown in the drawing, which represents an intermediate guard's van in the middle of a train, in which the brake chain is pulled simultaneously from both ends in putting on the brakes.

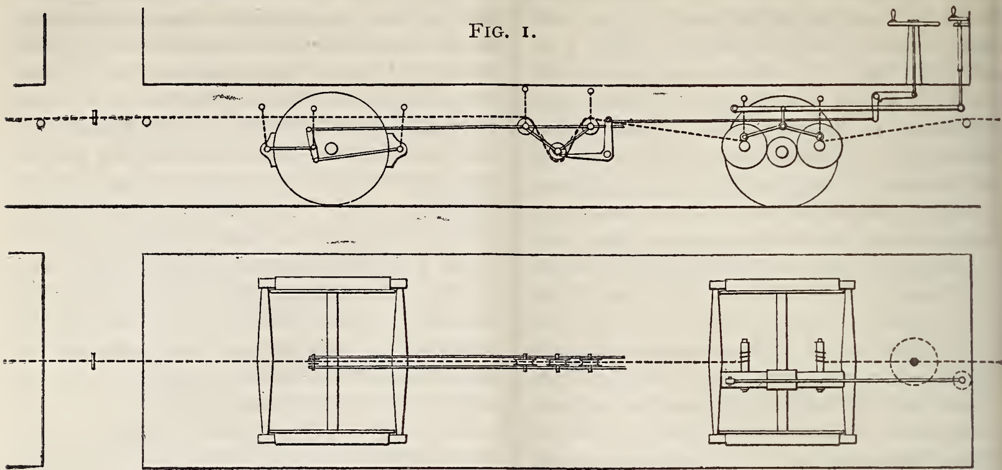
The brake blocks are each suspended by a link, each pair of blocks is connected by a compensating lever across the vehicle, and each pair of these levers is coupled by connecting rods to a vertical intermediate lever, which is suspended by a free link at a point half-way between the attachments of these connecting rods. The upper part of this intermediate lever is attached to the brake pull-rod, and when the pull comes on, each pair of brake blocks acts as a fulcrum to the lever of the other pair. The result of this arrangement is that all the brake blocks receive an equal pull, and mutually adjust themselves so that all act upon the wheels with equal pressure, notwithstanding any accidental variation in their wear. There are several varieties of this "brake rigging," as it is called, effecting the same object.

The brake blocks originally used were all wood blocks fixed upon iron arms; but these have been superseded by cast-iron blocks, which are much more durable, wear more uniformly, and are consequently much easier kept in adjustment. In the use of continuous brakes throughout a train it is essential for all the brake blocks to be uniformly and closely fitted to the wheels, so that all the brakes can go on and off simultaneously, and this is only practicable with metal brake blocks.

In the transmitting of the power from one vehicle to others through the medium of the brake chain, provision has to be made for taking up the slack of the chain that occurs between the carriages, where an allowance has to be made in the couplings of the carriages for the stretching of the draw springs. This provision is made by deflecting the brake chain under a pulley in the centre of each vehicle, this pulley being carried in a swinging frame which acts upon the brake levers by oblique thrust rods, so that the brakes are not put on by the direct pull of the chain but by the tightening of the chain pulling up the loop of the chain that is under each vehicle. By this means a number of vehicles can be connected together, and the brakes of all put on simultaneously by the tightening of the chain that is effected by winding up the end in the guard's van by the friction rollers. The same effect is also produced from the tender, a similar friction roller being fixed upon one of the tender axles, with a corresponding swinging roller upon the shaft upon which the end of the brake chain is wound; so that the brakes can be put on throughout the train either by the guard or by the driver.

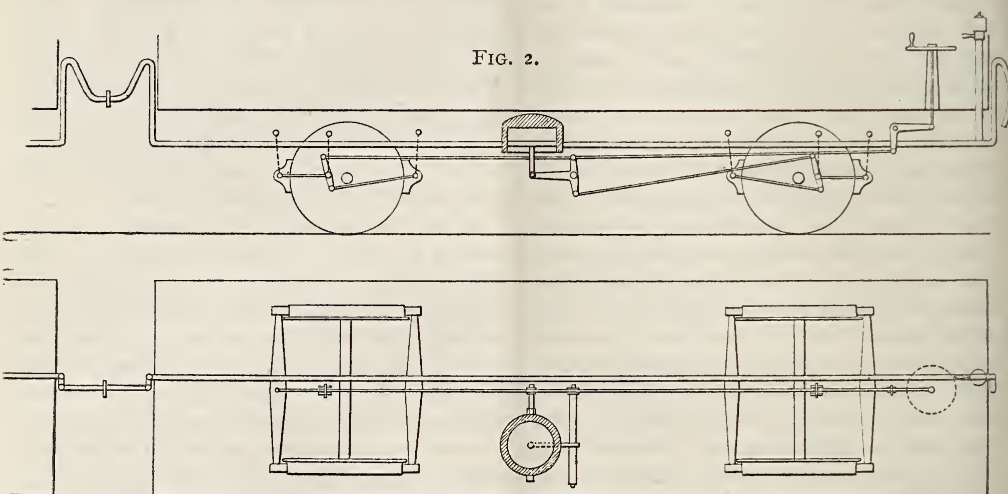
The guard has also the means of putting on the brakes of the van alone in the usual manner, by a separate hand-wheel and vertical

FIG. 1.



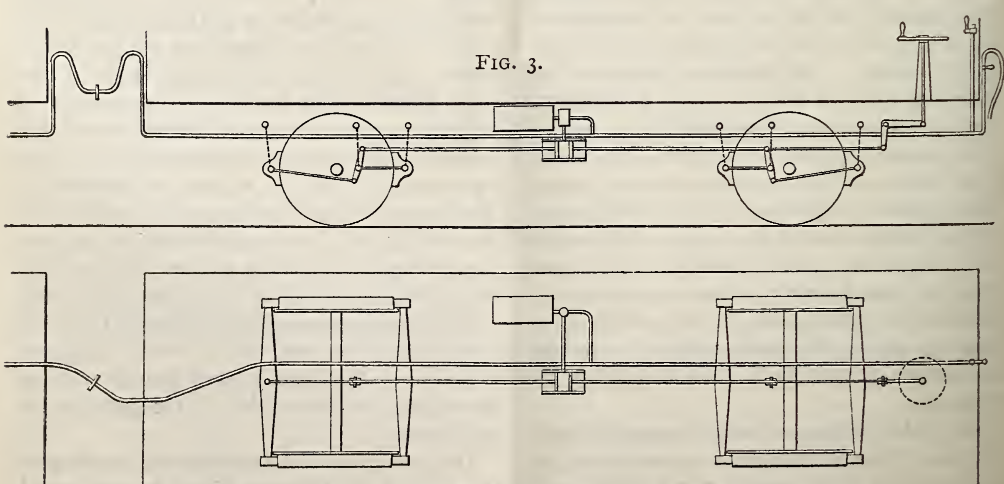
CHAIN BRAKE.

FIG. 2.



VACUUM BRAKE.

FIG. 3.



COMPRESSED-AIR BRAKE.

screw, as shown in Fig. 1, that pulls a bell-crank lever in the centre of the vehicle; which lifts up the centre pulley of the brake chain, in the same way as when the pulley is lifted by the brake chain being pulled tight, except that it acts only upon the brakes of its own vehicle.

Chain Brake, Automatic.—This is the most simple form of continuous brake, and it is made to a certain extent automatic by adding a lever in the guard's van, that is pulled up by a strong spring; this spring is ordinarily held down by a catch, but on being released presses the swinging roller into action, and so puts on the brakes. A communication cord is run along the train from the driver to the retaining catch of the lever in the guard's van, and by pulling this cord the driver can put on the brakes; or in the event of a portion of the train becoming disconnected, the pull caused upon the communicating cord will also put on the brakes in the rear portion of the train. This brake is found effective in ordinary working, and has the advantage of simplicity and freedom from risk of derangement in action, but it is limited in the number of vehicles in a train to which it can be continuously applied with satisfactory working, and it has an objection in the harsh jarring effect experienced by the passengers from the rigid pull of a metallic chain in putting on the brakes; also it does not thorougly fulfil the requirements of a continuous automatic brake.

Heberlein Brake.—In another arrangement of chain brake that is extensively used on the Continent, the Heberlein brake, the action is completely automatic. Each vehicle is fitted with an independent brake apparatus, and has a friction roller that winds up the chain of its own brakes only, and is pressed against the friction roller upon one of the axles by a constant weight upon a lever. This weighted lever is lifted by a cord at the end of the vehicle, which takes off the brakes; and all these lifting cords are coupled together by a cord extending along the top of the vehicles throughout the train to the guard's van, where the end of the cord is wound up by a hand-winch, to take off simultaneously all the brakes of the train. The brakes can then be all put on simultaneously by the guard releasing the cord, which causes all the weighted levers to drop, and to wind up the brake chains by the rotation of the friction rollers; this can also be done by the driver at the front end of the cord; or, in the event of the train becoming divided by an accident, the act of severing the continuous cord puts on all the brakes automatically. This chain brake is very efficient and simple, but involves the objection of unpleasant harshness of action like the other chain brake, and the brake goes on too suddenly and has objections of details in the completeness and convenience of application.

Fay and Newall Brake.—Instead of a chain for conveying the brake power from one vehicle to another, throughout the train, a square longitudinal rod is also used for making the connection between the carriages, this rod sliding in a square socket, in the end of a bar that runs the whole length of each vehicle. The brake power in this arrangement, the Fay and Newall brake, is transmitted by rotation of the bars running under the carriages, and the square sockets which rotate with them, at the same time allow for the play of the buffers and draw springs by sliding longitudinally, with a telescopic action, in the end sockets of the bars.

Air Brakes.—A continuous pressure pipe, carried through the whole length of the train, is also used as the means of conveying the power simultaneously to the brakes of all the vehicles. Water pressure has been tried for this purpose, but air is found the best medium for conveying the power, either by exhaustion or by compression; and the question of continuous automatic brakes has now become, practically, limited to a comparison of these two plans, the exhaustion plan, known as the "Vacuum" brake, and the compressed air plan, known as the "Westinghouse" brake. These have been gradually developed to their present high state of efficiency by a very long-continued series of ingenious improvements; and now, with both plans of air brakes, the whole of the brakes of all the vehicles in a long train, including also those of the tender and engine, are put on simultaneously by the movement of a single handle, either upon the engine, or in any one of the guards' vans; or, in the event of the train becoming divided by an accident, the whole of the brakes in both portions of the train are simultaneously and promptly put on automatically. It has to be noted that for the origination of both these important brake systems we are indebted to American talent, the Westinghouse Compressed-Air Brake, and the Smith Vacuum Brake, which have both been now a dozen years in use; and although much has been done in this country in developing the application of continuous brakes to passenger

trains, and particularly in maturing the vacuum brake, American practice is still ahead of us in the application of continuous brakes to goods trains, large numbers of goods trains being now worked in America with continuous brakes that control the whole train from the engine.

Compressed Air Non-Automatic.—The necessity for this has arisen from the circumstance of the very steep and long inclines that have to be worked on the railways in the mountainous districts of that country. I have had an opportunity recently of seeing the working of these railways, and in one case of particular interest, I travelled on the engine over a pass in the Rocky Mountains, having 15 miles ascent on one side, and 22 miles descent on the other side of the pass. This 22 miles was a continuous steep descent, averaging 1 in 40 inclination, with a portion as steep as 1 in 22, and the line was complicated by numerous sharp curves. The train was worked with a compressed-air continuous brake, applied to all the vehicles, and gave an interesting illustration of the working of the two systems of automatic and non-automatic brakes. The two engines were in front in going up, and the brake was worked automatic, so that if any portion of the train happened to become detached, it would be prevented from running back by the brakes being put on automatically by the act of separation of the connecting air-pipe, and the brakes would be kept on firmly until released by hand in each carriage separately. At the summit of the incline the brakes were all changed to non-automatic by reversing a cock in the brake apparatus of each carriage, which caused the brakes to be then directly controlled by the engine-driver, who kept the whole of the brakes on during the descent, partially easing or increasing their pressure every minute or two by a slight movement of the brake handle, and thus keeping the brakes constantly in gentle play; and the train was eased down the whole mountain side at a steady uniform speed of about 15 miles an hour. The working was thoroughly satisfactory, the train seemed to float smoothly and easily down the incline, and although this was for six miles of the very extreme average steepness of 1 in 27, part of this being 1 in 22, the speed of the train was as completely under the control of the driver as if running on a level; certainly an illustration of the very high degree of perfection in working railway inclines that has now been attained by the agency of air-brakes. The train ran down the whole 22 miles without stopping, but usually there are stops at three intermediate stations.

The great severity of this incline will be better realised when it is considered that the most celebrated ones in this country are the Lickey incline, between Birmingham and Gloucester, which is only 1 in 37, and less than a mile in length, and the Oldham incline, between Manchester and Oldham, which is 1 in 27, for half-a-mile length only; but the American incline is no less than 22 miles long, averaging 1 in 40, with six miles of it 1 in 27 (as steep as the Oldham incline), and a portion as steep as 1 in 22.

Vacuum and Compressed Air.—General views of the vacuum brake and the compressed-air brake are shown in Figs. 2 and 3, which are drawn for the purpose of comparison exactly on the same scale as the chain brake in Fig. 1, so far as regards the carriage frame, and the brake blocks and brake rigging; these latter vary in different arrangements of brakes, but the variations do not affect the question that has now to be considered of the best means of conveying brake power along the train. The portions of the brake work in the two systems that are used for non-automatic working are coloured blue in the drawings, and the additional portions that are required for working automatic are coloured red.

Both plans put on the brakes by the movement of a piston in a brake cylinder fixed under each vehicle, these cylinders being proportionate in area to the different pressures employed in the two cases; the vacuum pressure being about 9 lbs. per square inch, and the compressed-air about 50 lbs. per square inch on the brake pistons, giving in each case about one ton total pressure available upon the brakes in each single vehicle. The full pressure on the brake blocks is arranged to be as near as practicable to the point of skidding the wheels without actually skidding them, because the effective brake resistance for retarding the train is materially reduced the moment that the wheels are skidded.

In the compressed-air brake a store of compressed air for re-charging the train pipe is kept in a large reservoir upon the engine containing eight to ten cubic feet, into which the pump is always supplying air for keeping up the full pressure. In the vacuum brake there is not required any such store reservoir, as the pressure is obtained direct from the atmosphere.

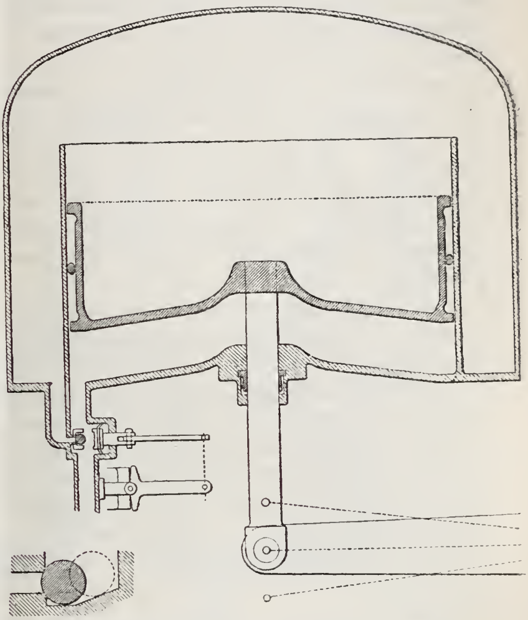
In the automatic vacuum and compressed-air brakes the automatic action is obtained from a reservoir that is carried under each vehicle, and is put into communication with the brake cylinder of the vehicle whenever the brakes are to be employed. These reservoirs are all in connection with the continuous train-pipe, by which they are charged at the starting of the train; a check valve at each reservoir retains this charge when the train-pipe pressure is subsequently reduced for putting on the brakes, and the check valve again opens for re-charging the reservoirs when the train-pipe pressure is again restored. In the vacuum brake the train-pipes are two inches bore, and in the compressed-air brakes the pipes are one inch bore, or one quarter the area of passage.

Vacuum Non-Automatic.—In the vacuum brake, Fig. 2, the power is conveyed by the train-pipe to an 18-inch cylinder under each vehicle, which in the non-automatic brake is open ended, and open to the atmosphere below the piston. The vacuum of the train-pipe then acts on the upper side of the piston, and pulls up the piston with a force regulated by the degree of vacuum that is maintained in the train-pipe. This degree of vacuum is adjusted by the driver's valve on the engine, and the brakes are taken off by admitting air into the train-pipe through the same valve, and so destroying the vacuum in the pipe.

Vacuum Automatic.—For working automatic, the brake cylinder is made closed below the piston, and the piston is acted upon on both sides, as shown in Fig. 4; the cylinder is enclosed in a casing that forms a vacuum reservoir for each vehicle. The action of the train-pipe is reversed from its action when working non-automatic, and instead of communicating with the upper side of the brake pistons, the train-pipe is connected to the under side of the pistons, the upper side of each being continuously acted upon by the vacuum in the reservoir originally obtained from the train-pipe, and retained in the reservoir by the check valve. This check valve is shown separately, in Fig. 4; it is a metal ball that rolls up a short incline in opening, and rolls down again in closing.

By filling the train-pipe with air, the underside of each of the brake-cylinder pistons is opened, practically, to the atmosphere, and the vacuum above the pistons is then free to act to its full extent, and pulls up the pistons, putting the brakes full on. When the full vacuum in the train-pipe is restored, each brake piston has the same vacuum both above and below it, the lifting power ceases, and the brake pressure is removed. Then by maintaining in the train-pipe any intermediate degree of vacuum, this brake pressure is graduated to any desired amount between the two extremes of "brakes on" at full pressure, and "brakes off;" the acting pressure on the brake pistons being the difference between the vacuum above and the vacuum below them.

Fig. 4.



Vacuum Brake Cylinder.

The pressure in the train-pipe can be maintained steady by the driver, and as the air remains stationary throughout the brake cylinders and train-pipe, the pressure is maintained uniform in all the brake cylinders of the train, until a change of brake pressure is required from change of gradient, or otherwise; and it is then re-adjusted by the driver altering the pressure in the train-pipe. This pressure is constantly indicated by a vacuum gauge on the engine, and can be regulated with great exactness. This gauge is marked like a barometer, with inches of equivalent mercury column (as shown in the diagram on the wall); 30 inches, or 15 lbs. per square inch, being a perfect vacuum, and the vacuum ordinarily maintained is about 20 inches, or 10 lbs. per square inch pressure, and

this is reduced to give about 3 to 5 lbs. per inch differential pressure in the brake cylinders for putting on the brakes in ordinary working.

The Guard's Valve for putting on the brakes is shown in the same diagram, full size, and acts by the valve being lifted up by a handle for admitting air to the train-pipe; and this valve is made to open automatically when the brakes are put on suddenly by the driver, for admitting air simultaneously at both ends of the train-pipe. Above the valve is a chamber communicating with the train-pipe by a small intermediate passage, and having a flexible diaphragm at the bottom which is connected to the valve by a centre spindle. This chamber has the same vacuum ordinarily in it as the train-pipe; and when the train-pipe pressure is suddenly lowered by the driver, the vacuum in the chamber pulls up the valve, and opens the train-pipe before the change of pressure can be communicated through the small intermediate passage.

This diagram also shows the automatic drip-trap, full size, that is used for continuously draining off water from the train-pipe; it is closed at the bottom outlet by a ball valve, which is held up to its seat so long as there is a vacuum in the train-pipe; but each time the vacuum is destroyed in the train-pipe this valve falls back, and opens the outlet for discharging the water collected in the trap. It is requisite to avoid any accumulation of water in the pipes, to prevent a risk of obstruction from the formation of ice.

When a carriage is detached from a train for shunting at a station or otherwise, the brakes would be put on automatically by the act of uncoupling the train-pipe; but this is prevented by opening the check valve at the bottom of the reservoir, and admitting air to discharge the store of vacuum in the reservoir; the valve is opened by pulling a cord at either end of the carriage that is attached to a short lever at the valve, as shown in Fig. 4 (p. 419). In the compressed-air brake a similar provision is made for discharging the reservoir when a carriage is detached from a train, and also provision for draining off any accumulation of water from the train-pipe or reservoirs.

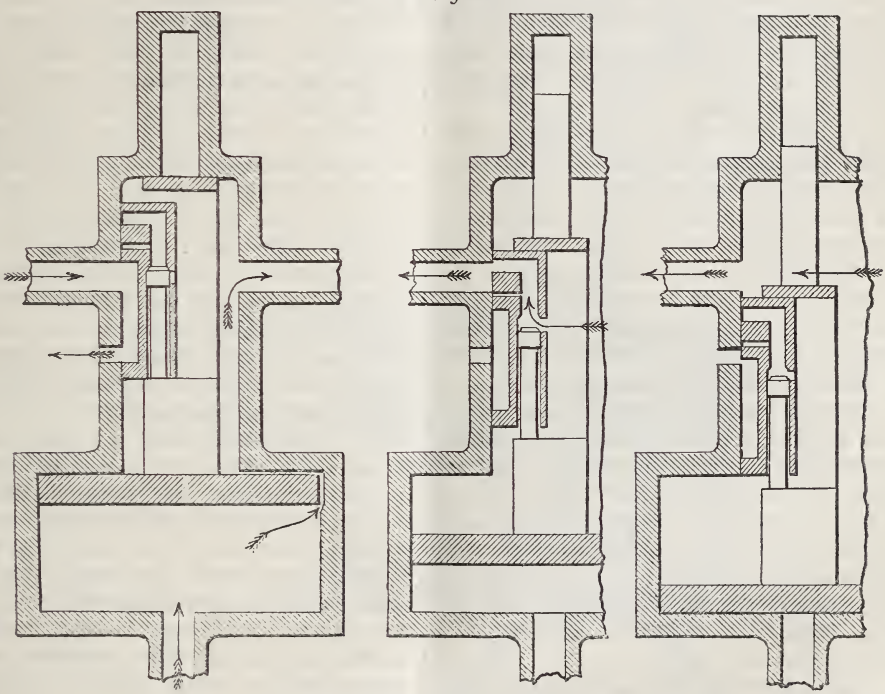
Eames's Brake.—There are other varieties of the vacuum brake in use in this country besides the one that has been described, but these are getting gradually merged in the complete form here shown. There is, however, another form in use in America, the Eames brake, in which the essential difference is that the brake cylinders are open-ended, being made not with a piston, but simply with a flexible diaphragm across the mouth of the cylinder, which is drawn inwards when a vacuum is made in the cylinder, and this pulls the brake rod. But the consequence of the cylinder being open-ended is that, in order to work automatic, a special graduating valve is required for regulating the admission of vacuum (if the expression may be used) from the carriage reservoir to adjust the amount of brake pressure. The graduating valve chamber (shown in the diagram on the wall one and a-half times full size) is closed by a flexible diaphragm at each end; the smaller of these diaphragms is open to the atmosphere, and the larger one has the train-pipe vacuum at the back of it. The space between the two diaphragms is in communication with the vacuum reservoir of the carriage, and the two diaphragms are coupled together by two connecting rods, which are attached to opposite ends of a bell-crank lever within the chamber. This bell-crank lever, is so arranged that when the connecting rod of the larger diaphragm is at its greatest leverage, that of the smaller one is at its least leverage. But as the two diaphragms move outwards, the leverage of each gradually changes until they become nearly equal. This motion outwards follows on a reduction of vacuum in the train-pipe which acts on the back of the larger diaphragm; and, the atmospheric pressure on the small diaphragm remaining constant, the two diaphragms then continue moving until the alteration caused in their respective leverages corresponds to the altered pressure, and brings them again into equilibrium, when they remain stationary until some further change of pressure is made in the train-pipe. The result is that the bell-crank lever is shifted into different stationary positions with every change of pressure that is made in the train-pipe, and corresponding changes are made in the positions of the two air valves that are actuated by the two ends of the bell-crank lever. The left-hand valve opens into the atmosphere from the brake cylinder, and is opened when the full vacuum is in the train-pipe taking the brakes off. Admission of air to the train-pipe shuts the left-hand valve and opens the right-hand valve, which admits the vacuum from the reservoir to the brake cylinder, and puts on the brake pressure; the amount of this pressure being graduated by

limiting the extent of opening of the valve and shutting it again before the full vacuum is reached in the brake cylinder, by again increasing the vacuum in the train-pipe.

By this contrivance, the driver is enabled, by making certain definite changes in the vacuum pressure of the train-pipe, to open or shut, when desired, the admission and discharge valves of the several brake cylinders; and if the train-pipe pressure can be adjusted in this manner with sufficient delicacy, both valves can be held shut after any desired amount of pressure has been produced, retaining that pressure on the brakes until the time when a further change is desired. This mode of graduating the brake pressure, however, involves so much delicacy in manipulation as to suggest a doubt whether it can be fully relied upon in regular work.

Compressed Air Automatic.—In the compressed air automatic brake the brake cylinders, 8 inches diameter, are also open-ended, and the graduation of the brake pressure has consequently to be effected by means of an intermediate graduating valve, which is shown in Fig. 5. This valve is actuated by a small piston, $2\frac{1}{2}$ in. diameter, which has the train-pipe pressure always on the under side, and the carriage reservoir pressure on the upper side. When the full pressure is in the train-pipe, this piston is

Fig. 5.



Compressed-Air Graduating Valve.

pushed to the top of its stroke, and the slide valve is pushed up and opens the exhaust from the brake cylinder, which takes off the brakes, as shown in the left-hand figure. On discharging the compressed air from the train-pipe, the piston is pushed down by the reservoir pressure above, and draws down the slide valve, as shown in the right-hand figure, opening the direct communication from the reservoir to the brake cylinder, and putting the brakes full on. This intermediate valve is required for graduating the pressure on the brake piston, because the brake cylinder being open-ended, the piston is situated between two constant pressures, the reservoir pressure on one side and the atmosphere on the other side; and the intermediate valve is required to check the admission of the reservoir pressure into the brake cylinder, in order to graduate the effective pressure on the brake piston.

In the arrangement of close-ended brake cylinder, as in the vacuum automatic brake used in this country, the brake piston is situated between a constant reservoir pressure on one side and a variable train-pipe pressure on the other side; and this variation of pres-

sure in the train-pipe being under the direct control of the driver, the effective brake pressure is also under his direct and continuous control, without any intermediate graduating valve being required.

Steel McInnes Brake.—There is another compressed-air brake included in the Board of Trade return, the Steel McInnes brake, which is on a similar arrangement, with close-ended brake cylinders, that have the constant reservoir pressure on one side of the brake pistons, and the variable train-pipe pressure on the other side, thus graduating the brake pressure direct, without the use of an intermediate valve. This brake is, however, only in use to a very small extent, and it is only now referred to as completing the illustration of the two plans of working, namely, the direct control and the indirect control through an intermediate valve, both applied to both the vacuum and the compressed-air principles of brake.

The *automatic action* of both the vacuum and the compressed-air brakes is obtained by the circumstance that the brakes are put on in both cases by the act of opening the train-pipe to the atmosphere; so that any severance of the train-pipe by an accident, such as the breaking away of the rear portion of a train whilst going up an incline, causes all the brakes to be suddenly applied, and prevents the running back of the detached vehicles.

In both the vacuum and the compressed-air brake there is a provision in the guard's van for putting on the brakes of the van itself, by means of a hand-wheel and vertical screw, as shown in Figs. 2 and 3, which act independently upon the brake rigging of the van, the connection being made by a slot-hole, so that, although the hand gear can pull the brakes, it does not prevent the automatic gear putting them on.

Vacuum Ejector.—The mode of creating the pressure in the vacuum brake is by a steam ejector, shown in Fig. 6 (p. 423); this acts on the principle of the steam blast in a locomotive chimney, and exhausts the air from the train-pipe and reservoirs. Two ejectors are used, a small inner one that is always in action, for maintaining the vacuum whilst the train is running and replacing leakages, which is worked by a separate screw-handle; and a second larger ejector which is used for taking off the brakes, and rapidly exhausting the train-pipe before starting. The driver's handle moves two disc valves; the outer one for the admission of air to the train-pipe to reduce the vacuum and put on the brakes, and the inner valve for the admission of steam to the ejector to restore the vacuum in the train-pipe and take off the brakes. The steam valve is open in one extreme position of the handle, and in the other extreme position the train-pipe is fully open to the atmosphere for putting on the brakes to the full extent; and at an intermediate position of the handle both valves are shut, and the train-pipe is then maintained at the steady vacuum pressure at which it had been previously adjusted.

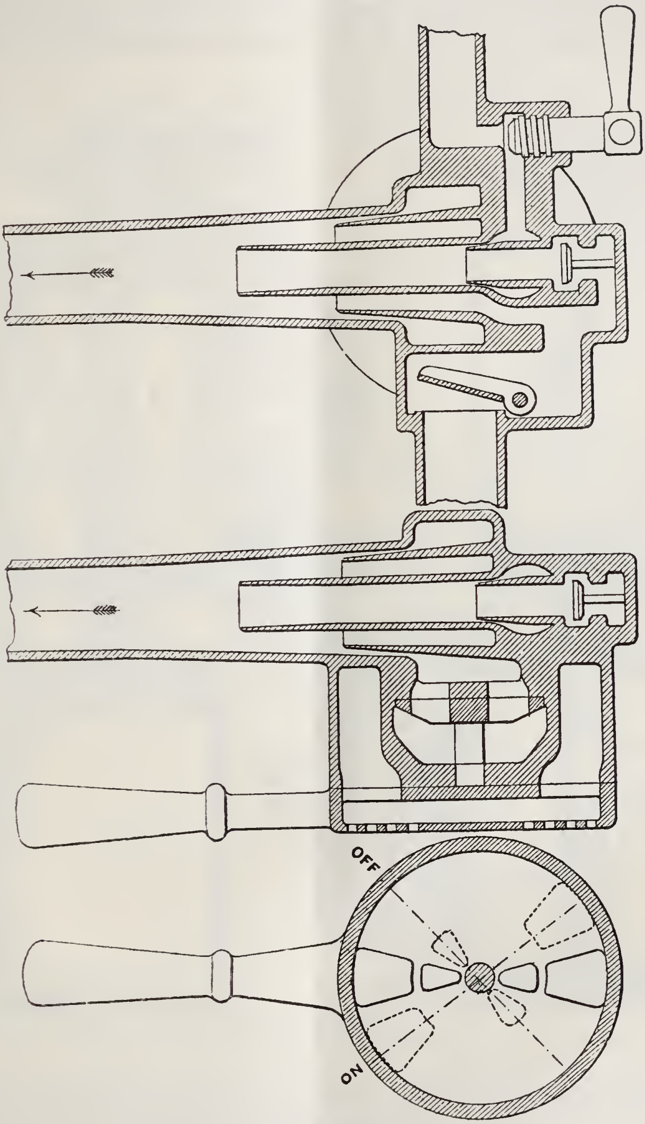
Compressed-Air Pump.—In the compressed-air brake the pressure is supplied by a donkey-pump on the side of the engine, shown in Fig. 7 (p. 424), that is self-acting with a tappet motion for the steam and air valves. A small auxiliary slide valve on the top of the steam cylinder is pulled down when the piston arrives at the bottom of its stroke, and admits steam pressure to the top of the main valves of the steam cylinder, as shown in the left-hand figure, pushing them down and admitting steam to the underside of the piston for the up-stroke. When the piston arrives at the top, it pushes up the small auxiliary slide valve, as shown in the right-hand figure, and lets out the steam from above the main valves; and then the upper of the two main valves being larger in area than the lower one, the total steam pressure upon it is greater, and the two are pushed up together by the pressure of the steam between them, and steam is admitted above the piston for the down stroke. The pump is kept continuously at work maintaining the pressure in the train-pipe and reservoirs, and replacing leakage; it works faster or slower according to the rapidity with which the compressed air is taken away from it, working very slowly whilst the train is in ordinary running, and then starting off quicker when a sudden demand arises from air having been let out of the train-pipe.

The whole of the movements required in working both the vacuum and the compressed-air brake are obtained by different positions of the single handle of the driver's valve upon the engine, the brakes being put full on in one extreme position of the handle, and taken off by moving it to the other extreme position; and graduated applications of the brakes are given by intermediate positions of the handle.

Compressed-Air Driver's Valve. — The driver's valve for the vacuum brake has been described in connection with the ejector. The driver's valve for the compressed-air brake is shown in Fig. 8 (p. 425). It consists

of two portions moved simultaneously by the same handle, and a supplementary valve at the bottom. The top valve is for discharging the compressed air from the train-pipe to put on the brakes; it is held down by a spiral spring within the socket of the handle, and this socket has a screw thread upon it, and rises as the handle turns, which causes the spring to be slackened to different reduced pressures, according to the extent of motion of the handle. The compressed air in the train-pipe then lifts the valve, as shown in the right-

FIG. 6.



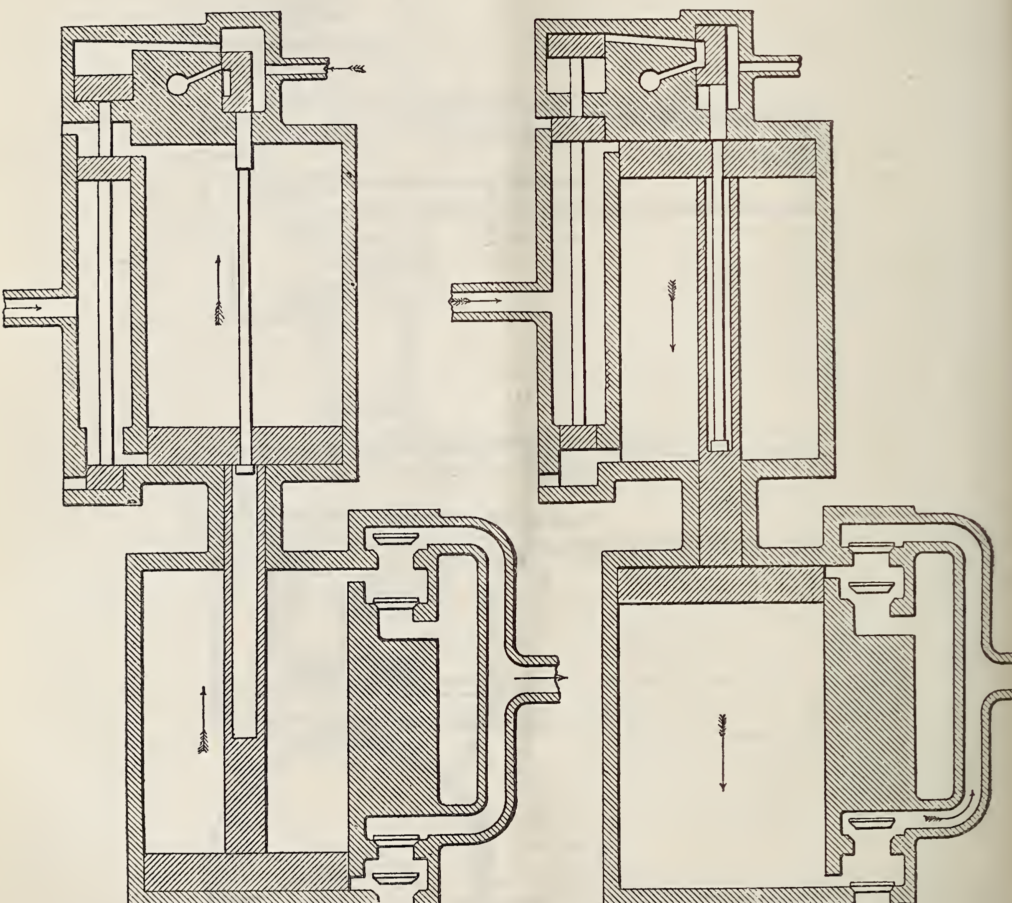
VACUUM EJECTOR.

hand figure, and escapes until its pressure is lowered to that of the valve spring, when the valve shuts again, and by this means the train-pipe pressure is regulated by the driver. The middle valve is a disc with two holes in it, through which the compressed air from the reservoir of the engine pump passes into the train-pipe, as shown in the left-hand figure, to charge the pipe with full pressure and take off the brakes. This valve is connected to the handle by a square sliding socket, allowing the valve to rotate without rising with the handle.

This valve is always shut, excepting when the handle is in its extreme position, and the supplementary bottom valve is for the purpose of providing a constant small feed of compressed air into the train-pipe, for replacing leakage, and maintaining the full pressure in the pipe whilst running. This supplementary valve opens to a small passage through to the train-pipe (as shown in the centre figure), which is open when the driver's valve is set in "running" position. The two extreme positions of the handle are "brakes off" and "brakes full on," and the intermediate positions are for graduating the pressure upon the brakes.

Comparative Quickness.—An advantage in quickness of action is intended to be gained by the use of the intermediate valve in the compressed-air brake; a small reduction of pressure in the train-pipe is sufficient to move all the intermediate slide valves when they are in

Fig. 7.



Compressed-Air Pump.

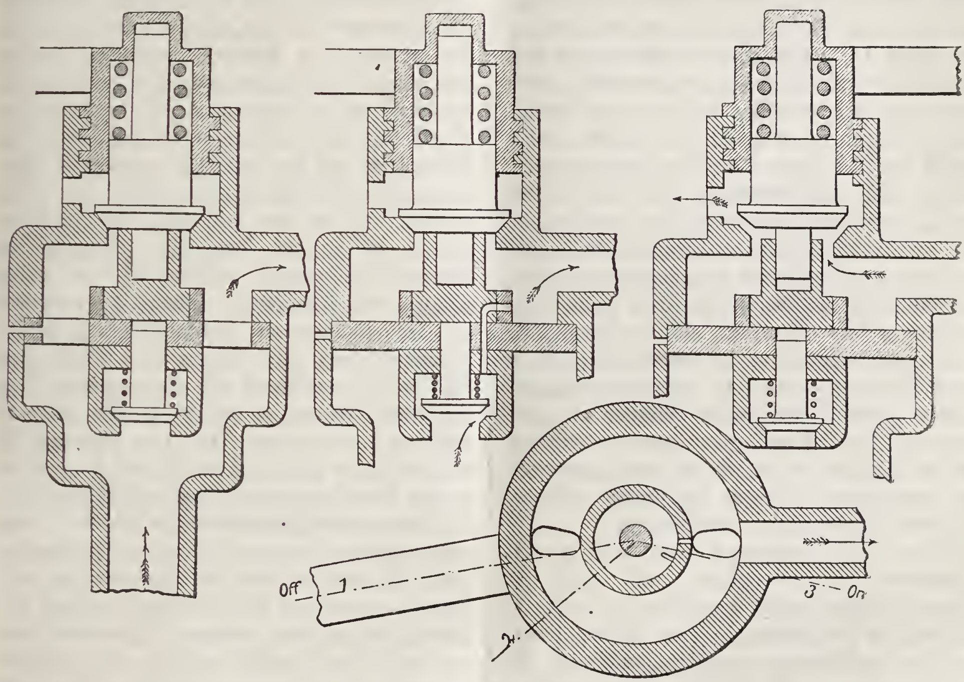
good order, and thus open the communication from each reservoir to its brake cylinder, so that, in order to put all the brakes full on, no longer time is requisite than that necessary for discharging sufficient air from the train-pipe to reduce the pressure at the far end so much as to open the slide valve of the last vehicle, and none of the air to fill the brake cylinders has to be supplied through the train-pipe.

In the other arrangement, as used in the vacuum brake, each brake cylinder has to be filled in putting on the brakes with air supplied through the train-pipe, the effective pressure being given by that air acting against the vacuum on the other side of each brake piston; and before the brakes are full on, time has to be allowed for the passage of air from the atmosphere through the train-pipe, which is made in this case four times the area, being 2 in. diameter in the vacuum brake and

1 in. in the compressed air. The time of passage is shortened by the air being admitted at both ends of the train-pipe in the vacuum brake, the guard's valve in the last vehicle being opened automatically when the train-pipe vacuum is suddenly lowered; and in long trains air is also admitted automatically at the same time at other places, in intermediate guards' vans. In the compressed-air brake the air is passed through at the engine end of the train-pipe only.

In the comparison of the speed of passage of the air along the train-pipe, it has to be noticed that although the compressed-air brake has a greater difference of pressure to propel the air, being seven times greater than in the vacuum brake, taking the two pressures at 70 lbs. and 10 lbs. respectively in the train-pipes, this does not increase the velocity of flow, because the density of the air to be put in motion is also increased to the same extent, and the head to produce motion in the compressed air is diminished by the greater density of the air in the same proportion as it is increased by the greater pressure, thus leaving the resultant velocity the same in both cases; so that the two brakes are on an equality in this respect.

Fig. 8.



Compressed-Air Driver's Valve.

From the practical results of working, it appears that a high degree of efficiency in promptness of putting on the brakes in an emergency has been obtained with both systems of brake, and they may be considered as closely on an equality in that point. As an illustration of the high degree of perfection that has now been attained in the application of brake power to trains, it may be named that a heavy train entering a station on the level, at the full speed of 50 miles an hour, can be stopped before the engine has travelled the whole length of the platform. Remarkable results have also been obtained in stopping trains whilst running down steep inclines.

An important point to keep in view in all plans of continuous brakes is that they should be suitable for the regular work of ordinary stopping at stations, in order to ensure that the whole apparatus is maintained constantly in complete working order; and that in any emergency there is not any change required from ordinary action in applying the brakes, except in applying the full force at once, instead of the moderated brake power that is sufficient for the ordinary station stoppages.

Compressed-Air Automatic Action on Inclines.—In the automatic working of the compressed-air brake down a steep incline, down which the train is propelled by gravity alone, and is required to be continuously controlled by the brakes, to prevent the speed ever exceeding the limit fixed for the safe working of the incline; the effective working pressure in the brake cylinder has to be continuously regulated by the driver, and graduated to suit the varying circumstances of gradients and curves upon the line, that is, the variations in propelling power due to changes of gradient and the variations in resistance due to curves. This regulating is effected by the driver letting out a portion of the charge of compressed air from the train-pipe, so as to reduce the pressure under the piston of each graduating valve, Fig. 5 (p. 421), and open the slide valve that admits compressed air from the reservoir to the brake cylinder of each vehicle, but not admitting a full charge to the brake cylinder, which would put the brakes hard on and stop the train; and then shutting the slide valves again, when a sufficient supply of compressed air has passed into the brake cylinders to produce the required brake pressure for maintaining uniformly the desired speed of train. For producing this effect, the slide valve and its piston are required to be moved up again a short distance, enough to shut the communication between the brake cylinder and the reservoir, but not enough to open the exhaust port of the slide valve, which would discharge the compressed air from the brake cylinder, and take off the brakes completely.

It has been supposed that this partial movement of the piston and valve is effected automatically, and that the valve is arrested in its motion in one of two intermediate positions successively, one with the admission port only slightly open, and the other with the port closed, but the valve not moved so far as to open the exhaust and empty the brake cylinder, and that this is effected by the pressure becoming quickly balanced on the two sides of the valve piston, in consequence of the changes in the capacity of the space occupied by the compressed air above the piston that is caused by the opening of the brake cylinder. It has been supposed that the first movement downwards of the valve piston is effected by so slight a reduction of pressure in the train-pipe, that before the valve piston has reached the bottom of its stroke, the reservoir pressure above the piston becomes so far reduced by the expansion caused by its admission into the brake cylinder, as to only balance the train-pipe pressure below the valve piston, and cause the moving power upon the piston to cease; and that the further expansion of the reservoir air, due to the further increase of capacity from movement of the brake piston, then causes a preponderance of pressure below the valve piston, until this has moved up again slightly to reduce the capacity above, and so bring about another balance of pressure to hold the valve stationary, in the position of shutting the communication to the brake cylinder, but not moving the valve so far as to open the exhaust and take off the brakes.

This description of the supposed action is necessarily imaginary in character, because the slide valve is not actuated by any gearing giving it a definite propelling motion into these intermediate positions between the extremes of its movement, the only means of effecting such adjustments being successive balancings of the internal pressures from changes in the space occupied by the compressed air of the reservoir. There is no means of seeing into the chamber to observe the actual motion of the valve piston, and it appears difficult to conceive of adjustments so delicate being really practicable in the apparatus. There has also to be considered the circumstance that the whole extent of motion of the valve is only an inch between the two extremes of brakes full on and brakes off, and its motion is only about a quarter of an inch between the two intermediate positions in which it has been supposed to remain standing; and as the total capacity of the valve cylinder is only about 1-400th of the air space above the piston, the extreme change of pressure producible by movements of the valve piston through its whole stroke would be only 1-400th of the pressure in the reservoir.

There has further to be considered the circumstance that any small changes of pressure would not be communicated the same at both ends of the long train-pipe, and delicate changes of adjustment of pressure below the valve piston of the first vehicle from the engine would not be applied the same at the valve piston of the last vehicle in the train. Considering the circumstances, first, that the pressure in each brake cylinder can only be put on by pulling down the slide valve by means of reducing the pressure in the train-pipe; second, that the brakes are put full on, so as to stop the train if the slide valve is

allowed to remain down, and is not pushed up again by restoring the pressure in the train-pipe; and, third, that the brakes are taken off entirely if the slide valve is allowed to remain up, and is not pulled down again by reducing the pressure in the train-pipe; the most probable mode of action of the automatic compressed-air brake in descending a steep incline seems to be an alternation of putting on and taking off the brakes at short intermittent intervals, continually repeated, and so adjusted as to supply an average brake resistance amounting to the required control of the speed of the train. An important consideration arising from this mode of action is that such intermittent changes of pressure will be fully effective only at the first vehicles of the train, and will be less and less effective towards the rear of the train, and the practical results may be, therefore, that, in braking the train down an incline, the brakes in the front portion only are really doing the work, and those of the rest of the train are only called into action when complete stoppage of the train has to be made.

In the comparison of the two systems of brakes, it has to be considered whether this mode of action is so satisfactory as the other principle of employing constantly all the brakes of the train, with a graduated pressure maintained equally upon all the brakes, and never letting go the hold upon the brakes. In working inclines, it is an old practical rule "never let go of the brakes," for the good reason that an increase of speed in a vehicle may carry it beyond the control of a brake that would otherwise have held it securely; and it does not seem a fully satisfactory mode of working to let go or slacken the hold upon the brakes even for short or momentary intervals.

In the case of descending a steep incline of very great length, such as the one in the Rocky Mountains previously referred to, which is a continuous descent of twenty-two miles in length averaging 1 in 40, with a portion much steeper, it is found unsuitable to work with the automatic compressed-air brake, because, in the words of the locomotive engineer of the line, Mr. Sample, the "auxiliary reservoirs cannot be re-charged without releasing all the brakes on the train, and the train will, during this short time of release—fifteen to twenty seconds—gain such a speed on a down grade of 211 feet to the mile (or 1 in 25), that it is nearly impossible to regain control over it, especially when the rail is bad. For this reason, the triple valves and auxiliary reservoirs are cut out on steep grades down."

Compressed Air Non-Automatic.—When the compressed-air brake is worked non-automatic in this manner, the graduating valves and reservoirs being put out of action, every brake cylinder throughout the train is simultaneously acted upon direct from the engine, with a uniform continuous pressure, this being the graduated train-pipe pressure which is under the direct control of the driver. The practical objection to this plan is that a change in the brake system of every train has to be made each time of descending a long steep incline, by reversing a cock in each vehicle, which throws out of action the automatic apparatus; this adds a complication to the system of working that is objectional on its own account, and still more so from the circumstances that it involves the risk of some of these cocks being accidentally omitted to be set right again on arriving at the foot of the incline, thereby causing the brakes of such vehicles to fail to act automatically in any subsequent emergency. Also during the time of the non-automatic working the brakes will not apply themselves automatically if the train should get divided by a broken coupling, or if an air coupling pipe should burst, and although there is little probability of a broken coupling occurring during a steep descent, it is not satisfactory to have lost the automatic control.

Vacuum Non-Automatic and Automatic.—In the vacuum brake, as used in this country, this difficulty does not arise; the non-automatic vacuum brake used on many of the railways acts exactly similarly to the non-automatic compressed-air brake for descending inclines, and every brake cylinder throughout the train is simultaneously acted upon direct from the engine with a uniform continuous pressure, this being the difference between atmosphere pressure and the graduated train-pipe vacuum which is under the direct control of the driver. Then, with the automatic vacuum brake, the action is also practically the same in descending inclines, and every brake cylinder throughout the train is simultaneously acted upon direct from the engine with a uniform continuous pressure, this being the difference between the vacuum in the reservoirs and the partial vacuum in the train-pipe, which is under the direct control of the driver. Some long steep inclines upon the Continent are stated to be so worked, including the St. Gothard Tunnel and approach, 18 miles length, with an average gradient of

1 in 45, and a portion 1 in 38, the whole 18 miles being run down without stopping in 1½ hours; but usually there are stops at three intermediate stations.

The compressed-air automatic brake is stated to be also used upon some long steep inclines on the Continent, including the Black Forest railway in Baden, 18 miles in length, 1 in 55, with part 1 in 50 gradient.

Comparison of Automatic Brakes.—In the comparison of the two automatic air brakes there are the two independent questions to be considered—First, whether vacuum or compressed air is the most efficient and convenient means for conveying the power to the brakes; and, second, whether in the application of the power the direct control by the use of close-ended brake cylinders, or the indirect control by means of intermediate valves and open-ended brake cylinders is the best, this last question being independent of the first one as to the use of either vacuum or compressed air. And there is also to be taken into consideration the difference in complexity of mechanism between the two plans of air brake, and the importance of obtaining the greatest possible simplicity of construction that is compatible with thorough efficiency of working; in the brake apparatus of a train, that is required to be always reliable for prompt action in an emergency, and is exposed to the rough usage of railway working.

In the vacuum brake, besides the driver's valve, which is not very different in character in the two brakes, the only mechanism is the ejector, acting by a jet of steam without a piston, and the check valves of the brake cylinders and the guard's valve; but in the compressed-air brake there are the steam pump for compressing the air, and the graduating valves with their pistons, and the lubricating and cleaning of these valves has to be periodically attended to, for keeping them in free action and preventing risk of the valves sticking. In the Board of Trade return of continuous brakes, several cases are reported of these valves sticking, and it has to be noticed that in such cases the driver is powerless to remove the obstruction and start the valve again, if it will not move with the difference of pressure available in the train-pipe, which is the only moving force that can be brought to bear upon the valve. In the vacuum brake the piston of the brake cylinder works with a rolling flexible ring, and both the piston and piston-rod work without lubrication.

An important difference in the working of the brake cylinder in the two systems is that, in the compressed-air brake, a portion of the store of compressed air in the reservoirs is discharged every time the exhaust of the brake cylinder is opened in taking off the brake or in graduating the pressure, and this requires the reservoir to be re-charged each time for keeping up the pressure; but in the vacuum brake arrangement there is not any discharge from the reservoir, and the store of vacuum in the reservoir acts as a constant spring, simply compressed and expanded with the alternate positions of the brake piston; and the only recharging required is to replace leakage, which appears to be very small in amount.

This is a point of much importance, because for a thoroughly satisfactory brake it is required that it shall be ready at all times for instant application, however often or however recently it may have been previously applied, and that it may be relied upon without risk of uncertainty in such cases as a driver having to make several stops and starts in rapid succession from signals being against him, and still requiring to retain full brake power over his train for entering a steep descending gradient that requires continuous braking of the train for keeping the speed under proper control. The brake power, in the case of both the brakes, is the power (either vacuum or compressed air) that is stored up in the reservoir of each vehicle—and in the compressed-air brake a portion of this charge stored up in the reservoir is lost every time the brakes are taken off—and in order to keep up the full brake power, it is requisite for the reservoir to be recharged each time to the extent of this loss; and in the case of several stops occurring in rapid succession, there is involved the risk of the exhausting of the reservoir being greater than the process of recharging can keep pace with, and a consequent reduction of reservoir pressure occurring that would cause the brakes to be not fully effective, as no recharging of the reservoirs can be effected without first taking the brakes completely off, and keeping them off long enough for the reservoirs to be recharged through the small opening at the edge of the intermediate valve pistons.

In the vacuum brake, however, as there is not any discharge from the reservoir, and the original store of vacuum is retained, acting only as an elastic spring that is alternately compressed and expanded, the above difficulty is avoided, and there is always, and under all circumstances of working, the full brake power

ready for instant application, however frequent the application may be.

Train-pipe Couplings.—In the flexible couplings of the train-pipes between the carriages of the vacuum brake, the pressure tends to tighten the joints, the pressure being external; but in the compressed-air couplings the pressure is internal, and tends to open the joints, and cause leakage, and the high pressure used, 70 lbs. per inch (or 80 lbs. in some cases), causes the accident of a burst coupling pipe to occur during the running of trains, which results in the accidental and unintentional stoppage of the train. The importance of this is seen from the Board of Trade return, in which there are reported in the first half of last year, in this country, as many as 250 cases of trains (or an average of $1\frac{1}{4}$ per day) being delayed by the bursting of the coupling pipes in the compressed-air brakes during the half-year.

The two constructions of pipe couplings that are used are shown in diagrams on the wall. One figure is the vacuum brake coupling; the ends of the pipes are faced with india-rubber to make a nair-tight joint, and they are coupled by lifting them up sufficiently high to hook the bottom horns together; and then, on dropping the pipe, the top horns enter their corresponding notches, making the coupling complete. The other figure shows the compressed-air coupling, drawn three times full size. This has also india-rubber faces to make an air-tight joint, and these are forced together by two pairs of inclined planes that are twisted round a short way in the act of coupling. Both these couplings are so constructed that they can be separated by a moderate force pulling them apart longitudinally, so that, in the event of the train getting divided by an accident, the couplings readily separate without injury.

Stop-cock in Train-pipe.—The rear end of the train-pipe, at the back of the last vehicle in the train, has to be closed air-tight in each case. In the vacuum brake this is done by simply dropping the end of the flexible coupling pipe upon a fixed plug that fits the end of the pipe, and is held air-tight by the external atmospheric pressure whilst there is a vacuum in the train-pipe. In the compressed-air brake the end of the pipe is closed by shutting a cock in the pipe. This cock gives also the means of shutting off the train-pipe from the engine when the engine has to be temporarily detached from the train for shunting in a station, and in that case, the act of separating the train-pipe is prevented from putting on the brakes by the cock being shut. In the vacuum brake there is not any means of shutting off the train-pipe, and consequently the act of detaching the engine for shunting purposes puts on all the brakes of the train, if the vacuum reservoirs have been already charged by the engine; and in that case, if any of the carriages are required to be detached for shunting before the return of the engine, their brakes have first to be taken off by hand, by pulling the cord of the release valve. This does not appear, however, to involve any practical inconvenience or delay in working; and it has to be noticed that the plan of closing the train-pipe by a cock involves a possible risk of a cock being omitted to be re-opened before the starting of the train, which would cut off the power of applying the brakes in the rear vehicles; and the other plan, by necessitating the taking off of the brakes before starting by a momentary application of the large ejector, has the advantage of ensuring that the communication is complete throughout the train for putting on the brakes.

Summary.

The comparison of the two systems of brake may be summarised as follows:—

In total brake power and in the convenience of putting in action they are practically equal.

In promptness of action for putting on the brakes, both have attained a high degree of efficiency.

In the vacuum brake the direct action on the brake pistons gives the driver continuous and direct control over the brake pressure; in the compressed-air brake the action through the intermediate valves causes this control to be indirect and intermittent, and it is a question for practical consideration from the results of working, whether there is advantage gained in promptness of action to outweigh this disadvantage.

In the vacuum brake the pressure being low, a rolling packing without lubrication is used in the brake cylinders, and the pressure being external tends to close leaks, and avoids risk of burst coupling pipes; in the compressed-air brake, the pressure being high, requires rubbing packing with lubrication to be used for the brake piston, and the pressure being internal, tends to open leaks and involves the risk of a burst coupling pipe, causing the train to be stopped unintentionally.

In relative complication of mechanism, the vacuum brake has a steam jet without moving parts to be kept in order; the compressed-air brake has a pump and the intermediate valves requiring regular attention for lubrication and cleaning in order to keep them in working order. The driver's valve and couplings are practically equal in the two brakes.

In the vacuum brake the reservoir store remains constant, and the full brake power is always present and available for action, however frequent and rapid the previous applications of the brake may have been. In the compressed-air brake a portion of the reservoir store is discharged at each application of the brake, and this loss has to be replaced before the brake is ready for full action again, involving the risk of the brake power being below the full amount when required for action.

Comparison of Mileage.—The following information respecting the extent to which the several continuous brakes are now in use in this country, is added from the Board of Trade return for the first half of last year.

Eighty-four per cent. of the whole mileage of passenger trains was worked with continuous brakes, and of these there were:—

Vacuum automatic	25	per cent.
,, non-automatic ..	31	,,
Compressed-air automatic ..	34	,,
,, non-automatic	1	,,
Chain automatic	1	,,
,, non-automatic	6	,,
Fay and Newall brake ..	1	,,
	100	

Or, taking the totals of each kind of brake power, there were:—

Vacuum brake	57	per cent.
Compressed-air brake	35	,,
Chain brake	7	,,
Fay and Newall brake	1	,,
	100	

General Conclusions.

In conclusion, it has to be noticed that the high degree of perfection now attained by the two air brakes—vacuum and compressed-air—is the result of the remarkably ingenious and persevering exertions of many inventors, extending over a long period of years. It does not, however, come within the scope of the present paper to go into any questions of priority or originality of invention, nor to express an opinion as to the superiority of any particular plan, the object of this paper being a consideration of the mechanical question alone, and an endeavour to bring out clearly the special points that require consideration, and to supply materials towards arriving at a definite conclusion on the subject.

Some general conclusions may, however, be properly added, that have been derived from this examination of the different brake systems.

1st.—That air brakes, acting either by exhaustion or by compression, supply the best means for carrying out the requirements satisfactorily, and that the two plans now in extensive use, the vacuum brake and the compressed-air brake, both effect the required object with a high degree of success.

2nd.—That the application of air pressure, either exhaustion or compression, by means of close-ended brake cylinders, without intermediate valves, gives a direct and continuous control from the engine over the brake pressure in each vehicle, that meets all cases of railway working. But the application by open-ended brake cylinders with intermediate valves causes the control from the engine over the brake pressure in each vehicle to be indirect and intermittent, and not suitable for the descent of very long steep inclines.

3rd.—That automatic continuous brakes are essential for satisfactory working under the present conditions of speed and weight of trains, making the entire weight available for obtaining brake power ready at all times for pulling up the train in a short distance on any emergency arising, and certain to be applied automatically in the event of any portion of the train becoming detached by accident, to prevent it from running back, or in the event of part of the train getting off the line, to prevent the rear portion from running into it.

DISCUSSION.

The Chairman said Mr. Marshall was well-known to most of those present as the former Secretary to the Institution of Mechanical Engineers, for which he had laboured more than a quarter of a century, and no one probably had devoted more study to this subject. Whilst he held the office to which he had referred, there were very few inventions connected with railways which did not come before him, and since he had had more leisure, he had spared no trouble in studying the question more in detail. There could be no doubt of the great importance of this subject, whether one considered the

ability to work trains with facility, especially frequently stopping trains, or the safety of passengers. That continuous brakes required to be thoroughly trustworthy was clear, for this reason, that a driver relying on such a brake, which he knew as a rule he could rely on, came towards a station, or place where he had to stop, at a rate of speed which he would not dare use to under the old system, and that he could do so, was one of the advantages of having such brakes. If anything went wrong, and the brake failed, the result was extremely disastrous, but fortunately such accidents had been extremely rare up to the present time. When a man relied on a new power, it was most desirable that the reliance should not be a misplaced one. Attention had been called to the introduction of iron brake blocks, and he would remark that for years they were confined to wooden brake blocks, which, though the introduction of continuous brakes might give safety to the train, were the destruction of comfort to the passengers, because the wheels being held firmly and rubbed along the metals, flats were ground on them, and the effect was that you were travelling on a polygon instead of a cylinder, and railway comfort disappeared. The use of cast-iron had got rid of that to a very large extent, because there was now a rubbing friction between the wheel and the brake block; instead of the wheel being held fast, and the friction taking place on the rail, the wheel continued to turn, and its cylindrical character was preserved. He would also call attention to a paradox which used to exist in the use of brakes which were put on the guard's van, when infinite pains were taken, and great expense incurred merely to prevent their working. Great pains were taken to turn the central shaft accurately, to bore the hole accurately, and to put the shaft into it with the least possible chance of its playing sideways. Then two levers were put on, one to one brake block and another to another; and every effort was made to get them to bear on their respective wheels at the same time, but if they did not, the very excellence of the workmanship prevented one block being the abutment for the other as it ought to be. Then the curious suggestion was made that, if at the outset the blocks had not been made correct, they would wear themselves correct, and would both bear; but this was an entire fallacy, and for this reason: the prominent block caught its wheel first and stopped it dead; the non-prominent block was very near to its wheel, bearing some pressure upon it, but it did not stop it dead; therefore there was a rubbing between the block and the wheel that continued revolving, but none between the other block and its wheel, and by no possibility could these blocks ever wear themselves into equality. At that time he lived out of town, and had to come up by train every morning, and he made it his business to watch the action of the brakes as the train was pulled up, and he would undertake to say that, where the brakes were applied to all three pairs of wheels of a six-wheeled vehicle, by no chance did he ever see all three pairs stop at once, and where the brake was applied to two, it was rare to see both pairs stop at once. If people would only have indulged in a little slack work, it would have answered much better. That went on for years, and it was not until automatic brakes, and brake rigging came in, that the making of one block the abutment for the other, which had existed in ballast waggons and coarse work, was effected. It might interest the meeting to know the results of some experiments which were carried out some years ago on different kinds of brakes. On a perfectly level straight line, without any wind, a train running by itself, and allowed to die out, with no brake on at all, and with the cylinder cocks open so as not even to have the effect of the vacuum on the piston, starting at 50 miles an hour, and the train weighing 250 tons, ran for five miles before it came to a stop. It was then tried with various brakes; simple screw brakes, steam brakes on the engine, vacuum brakes on the carriages, and then all the brakes together, and to the best of his recollection the same speed which required five miles to bring itself to a stop with no brake at all, was brought up in about 300 yards with all the brakes applied. The result was that the best brakes took about three miles an hour of speed out of the train in each second of time, when applied to the bulk of the vehicles, viz., to four out of six. A train going 30 miles an hour would be stopped in 11 seconds, not quite three miles a second; at 40 miles an hour in $13\frac{1}{2}$ seconds; at 50 miles an hour in 17 seconds; and at 60 miles an hour in $23\frac{1}{2}$ seconds. Those were about the best results obtained.

Mr. E. WOODS (President of the Institution of Civil Engineers) said the only fault he had to find with the paper was that it had not been read before the Institution of Civil Engineers. The Chairman had referred to some experiments which he had the honour of conducting about eleven years ago for the Royal Commission to investigate the causes o accidents on railways and the means of averting them, if possible. The Commissioners found in the course of their inquiries a great want of information on the part of those connected with the working of railways, as to the actual results obtained from the use of the brakes at that time in use, which were chiefly ordinary hand brakes, one on the engine, one on the tender, and a brake in one or two vans in each train. One or two companies, notably the Lancashire and Yorkshire, had adopted a system of continuous brakes, a mechanical brake known as Mr. Fay's, and it seemed to have advantages, but the other companies were slow to adopt it or any other contrivance. The Royal Commissioners then applied to the different railway companies, who took the matter up heartily, and it was agreed that six of the leading companies should each prepare a train fitted up with one or other of the six or eight systems. This was done by the London, Brighton, and South Coast, the

London and North Western, the Midland, the Great Northern, the Caledonian, the Lancashire and Yorkshire, and one or two other companies. The ground selected for the trial was between Lincoln and Nottingham, and during the experiments, which extended over a week, the Midland Company arranged that the traffic should be worked on a single line, so that the Commissioners might have the continuous use of the line for the experiments. The Government allowed a detachment of sappers and miners, and the electric engineer of the Royal Engineers to assist in the signals, noting the times and speeds of the trains, and so on. The trials were of a somewhat extensive character, and went not only to determine the retarding power exercised by an ordinary brake, but also that exerted by different systems submitted for trial, some mechanical, as well as the Smith's vacuum and the Westinghouse. The general result had been stated by the Chairman. A train of 200 tons weight, impelled at a speed of 45 to 50 miles an hour, ran for three miles without stopping. That confirmed what had been pretty well known before, that the ordinary friction of railway carriages was equal to 8lbs. per ton of weight. They then tried the resistance of an engine and tender without a brake being applied, and found that came to about 14lbs. per ton, and as the result, a train with engine and tender all combined, could be stopped by 9½ lbs. to 10lbs. per ton of weight. When they came to apply the continuous brake to all the carriages, the train, which could only be stopped by the ordinary hand brakes in a distance of one mile, could be stopped in from 300 to 400 yards within 18 seconds of time. There was a considerable difference in the retarding power of different systems of brakes, and the air brakes certainly performed better on the whole than the mechanical brake. As a general result, it was found that the retarding forces exerted upon a train by one of the best class of brakes might be represented by supposing the train to be at the foot of a gradient rising 1 in 10. Such a force applied to a train weighing 200 tons, and going at 50 miles an hour, would arrest it in 275 or 300 yards; if going at 60 miles an hour, in 300 to 400 yards. They were precluded at that time from exercising any judicial functions, or attempting to determine which was the best brake submitted, but had simply to report their results to the Royal Commissioners. Mr. Marshall, however, had been able to give a kind of judicial opinion on some of the most important forms of brakes, and they were very much indebted to him for so doing. He had not given any measure of the retarding force exerted, except by stating the important effect which continuous brakes had in controlling trains in descending long gradients, such as those of the Rocky Mountains, 1 in 30 or 1 in 23, and no one could overrate the importance of such brakes in controlling such trains, and producing a uniform limited rate of speed. The retarding force of a good continuous brake might be regarded as about 1 in 10, which was equivalent to this—that such a brake would control the action of a train descending a gradient of 1 in 10, and that being so, it was evident there was a considerable margin between such a gradient and 1 in 20 or 1 in 30, which were now so common in different parts of the world.

Captain Douglas Galton, D.C.L., C.B., F.R.S., had listened to this paper with much interest, and felt much indebted to Mr. Marshall for his description of the mode of action of the two important brakes—the vacuum and the Westinghouse. Of course the real efficiency of the brakes depended on certain details which were not described. There was a question at one time whether, in applying a brake, the wheels should be made to skid or not, but it was now settled that, if the brake caused the wheels to skid, its efficiency was very much diminished, the brake being much more effective when the wheels were revolving than when they were sliding along the rails. Then there was another important point, which was brought out in the very valuable experiments made on the Brighton railway, with which he was concerned, in connection with Mr. Westinghouse—viz., the estimation of the force required to be applied to the wheel when revolving at a high velocity as compared to the force required when revolving at a low velocity. When a train was travelling very fast, you required a strong force to produce a sufficient controlling action on the wheel; but if that force remained applied to its full extent while the train was gradually stopping, it would soon be sufficient to skid the wheel. A perfect brake, therefore, would be one in which the force applied to the wheels at the highest velocity would, by some automatic arrangement, diminish as the train stopped, so as to always keep the wheels revolving, and, at the same time, always keep a retarding force applied to them. He did not know that there was any existing brake which exactly fulfilled these conditions.

Mr. G. A. Gutch said Mr. Marshall set out by saying that he approached this subject from an independent point of view, as an old railway man, and he quite believed that, but he did not think he could have acquired much knowledge of continuous brakes whilst he was Secretary of the Mechanical Engineers, as he retired in 1877, and, although he might have studied the Westinghouse brake in America, he did not think he would find any automatic vacuum brake, such as he had described, there; he certainly would not find any working on mountain grades, such as the Westinghouse worked on. He thought, therefore, that some of his information had been obtained second-hand, and that he was rather hasty in coming to the conclusion that the vacuum brake was likely to be of service on long down grades. There was no record of their having been worked on such grades. The Westinghouse was working, not only in America, but in Europe, on grades of 1 in 30, and 1 in 40, for ten to fifteen miles at a

stretch. There seemed a great deal of theory about the paper, and it would have been more satisfactory if Mr. Marshall had been able to give the practical experience of those who had worked the brakes. He said in one place that it was not within the scope of the paper to say which was the best brake, and in another place he stated that the automatic vacuum met all the requirements of railway work, which the Westinghouse did not, and this was rather a contradiction; the vacuum always seemed to come out the best when he was comparing the two. Again his description of the Westinghouse was not correct, the triple valve was assumed to do certain things which it did not, and the things which it did do it did not get credit for. If he had really wanted to understand all about the triple valve he might have gone to the company's works and seen and he would then have found that what he had described as purely imaginary, the graduating on inclines, was really a fact. He said you could not see into the interior of a triple valve, but there was one specially constructed, and shown at the Inventions Exhibition, which you could see into. The graduation was most perfect. To say it was put on intermittently in going down an incline was absurd; it was equivalent to saying that, when used to its utmost efficiency, you could stop at a certain speed in 100 yards, but you could not contrive to make it stop in 200 or 300 yards. You could put it on as gradually as you liked. He (Mr. Gutch) maintained that in all the trials which had ever been made the Westinghouse had never been beaten. It complied with more requirements of the daily work of railways than any other; could be put on quicker and taken off quicker than any other. It facilitated shunting, whereas the vacuum obstructed it. The author said he considered that, for promptness in applying the brakes in an emergency, both systems were on an equality, but he did not give any figures; now there were numbers of published experiments with regard to the time taken in getting the brake on, but no figures had been quoted to show the relative times of the vacuum and the Westinghouse. Then he said it was a question whether there was a gain in the promptness of action which would outweigh the disadvantage of the intermediate valve, so that it seemed as if he was inclined to think that the Westinghouse had a certain advantage in quickness of action. It would be very singular if it were not so, because forty times as much air had to enter the pipes of the vacuum brake, and distribute itself all through the pipes and cylinders, and that at a low pressure, as would flow out of the Westinghouse at a high pressure, and he did not see how you could make one act as quickly as the other. It was curious too, that Mr. Marshall never mentioned the relative times taken in releasing the brakes, which was very important also, second only in importance to quickness of application. The vacuum was very slow in this respect, and never could be anything else. According to the official statement, with a 20-inch vacuum, which was the standard, it took half-a-minute to restore the vacuum after it was destroyed, or to get the brakes off, which was a long time to wait. The Westinghouse could be released about as quickly as it could be applied. You only had to reverse the triple valve to at once restore full pressure; put on the regulator, open the driver's brake, and start at once; in the other case, you would be blowing half a minute before you could start. If you had full pressure on, the vacuum brake took half a minute, but if the pressure had fallen it would take longer. With the Westinghouse you were not dependent on the pressure in the boiler; it was contained in the main reservoir; you could put the brake on and off five or six times independent of the steam in the boiler; but you could not do that with the vacuum brake, you were dependent on the pressure of steam in the boiler. Approaching a station there might be five or six sets of signals taken off just at the last moment as you approached, and with the vacuum, which was so slow in release, you might not be able to start when you wanted to. Mr. Marshall seemed to think it was a great advantage in the vacuum that there was no discharge from the reservoir, and that the power was practically never disturbed, but always remained there for application, however frequent and rapid the previous applications had been. But rapid applications required rapid releases, and as it was impossible to release the vacuum brake rapidly, that statement was incorrect. Full power in the reservoir was all right enough for putting the brakes on, but when you wanted to take them off that power was acting against you. You wanted to produce the original amount of vacuum on the inside of the piston, and you could only do that slowly with the injector. It was a distinct disadvantage in any brake to have a constant irreducible pressure for putting it on. It was like a dead-weight of so much; so long as you were strong enough to master it, it was all right, but when it mastered you it was a nuisance. Again, supposing there were a leak in the pipe, the vacuum in the reservoir being higher than in the train-pipe, there was a tendency to put the brakes on. The man used the injector, which did not help to raise the steam, and after a time it might get lower and lower; and as the power in the reservoir had not been reduced the brakes would begin to act again; then the injector must again be used and take another 10 lbs. out of the boiler, and in a short time you might have to pull up because you could not restore the vacuum on the top side of the piston. He had known a case where the pressure in the boiler had gone down from 140 to 90, without being able to get the brakes off, and they had to go along the train and release them by hand. That resulted from the irreducible pressure in the top of the cylinder, which he considered a disadvantage. In the Westinghouse it could accommodate itself to circumstances, and there was no diminution of the pressure in the boiler. Then it was said that there was a main reservoir on the

locomotive for the release of the brakes in the Westinghouse, but the vacuum did not require it. That was an immense advantage; if it were not there you would have to pump the brakes off, just as the injector was used to suck them off slowly by the aid of the steam in the boiler. Then it was said the vacuum did not require a reservoir, as the pressure was obtained from the atmosphere. Of course it was, but where did the Westinghouse get its air from? The power for taking off either brake was got from the same source as that for putting them on, the steam in the boiler; in the one case the pump did it, and in the other the injector. With regard to the releasing the brakes of long trains when the couplings were undone for shunting, Mr. Marshall said this was not of much practical importance, but the first introducers of the automatic vacuum brake found it a very great nuisance not to be able to prevent the brake being applied when you detached an engine or carriage, so much so that when it was introduced on the Great Western and Midland that a special invention was made to meet the difficulty; and that brake was very popular with the drivers, because they could run either with or without the vacuum, and if the train was light it was not put on. But that system was frequently condemned, and it was now being done away with. But to get over these difficulties Mr. Clayton, of the Midland, took out two patents, the wording of which showed the importance which he attached to the pressure in the reservoir being able to accommodate itself to circumstances. The plan then introduced had now been abandoned, but the original disadvantage remained, and always would until there were some means of preventing the application of the brakes when the couplings were disconnected. Mr. Gutch concluding by quoting from a report of the executive engineers of one of the Indian railways made to the Government on the subject of brakes, some passages in which he spoke in very high terms of the Westinghouse brake.

The CHAIRMAN said this subject was so important that he would adjourn the discussion to Monday evening next, at eight o'clock.

The meeting was adjourned accordingly.

Miscellaneous.

WATCHMAKING IN FRANCE.

The following particulars respecting the manufacture of timekeepers in France, obtained from official reports, are communicated by Mr. J. Tripplin, Representative of the Besançon Chamber of Commerce in London:—Besançon, in the old province of Franche Comté, situate on the borders of Switzerland, is the centre of watchmaking in France. In 1876, 428,754 watches, of which 296,763 were silver, passed through the hall; these watches represented the sum of 22,000,000 francs. The production, which in 1846 was 54,192 watches, has gradually increased, and reached 501,602 in 1883; the population of Besançon engaged in the industry being 15,000. The watches manufactured, says Saunier, being good and sound, have conquered for themselves almost the entire French market, formerly tributary to the Swiss; the Swiss importations having gradually decreased, were reduced to 74,119 watches in 1883. Besançon possesses a school of horology and an observatory, of which manufacturers avail themselves for the purpose of timing watches.

The movements mostly used are made at Beaucourt, Montbéliard, Seloncourt, and the neighbourhood; these factories produced, in 1876, 1,440,000 watch movements in different stages of finish, besides 400,000 clock movements. Beaucourt itself produced 640,000 watch movements, of the value of 1,500,000 francs; Seloncourt, 215,000, and a large number of sets of pinions of the value of 700,000 francs; Montbéliard produced 18,000 escapement bearers, used in carriage clocks; and in the immediate neighbourhood, at St. Suzanne, 30,000 musical boxes were made. The total watch production amounting to 9,000,000 francs. What is not kept in the way of watch movements is taken by the Swiss, and almost all clock movements are sent to Paris and Morez du Jura. The total population of the Besançon district engaged in watchmaking amounts to 40,000; other localities, such as Morteau, where a factory of metal keyless exists; Montécheroux, les Gras, which manufacture largely watchmakers' tools; les Faucilles, where watch jewels are made; Maiche, le Russey and district, where cylinders, escape wheels, pallets, levers, screws, &c., are turned out in quantities, are all engaged in the industry.

The village of Cluses, whose working population is about 1,000, produces watch movements, pinions, wheels, wheel cutters, keyless works, barrel arbors, and sundry detached pieces to the value of 1,300,000 francs, most of which are taken by Switzerland. Cluses possesses also a school of watchmaking of good repute.

Morez du Jura stands first among those districts of France engaged more especially in clockmaking. The working population of Morez and district is 6,000, total productions amounts to 4,000,000, consisting of 70,000 Comté clocks, 20,000 regulators, and some turret clocks.

At St. Nicholas d'Aliermont, near Dieppe, are manufactured carriage and other clocks, chronometers either in the rough or finished, regulators, &c., to the value of 144,000 francs; the working population being 950.

Paris, the cradle of such horologists as Thiout, Antide Janvier, Pierre Leroy, Berthoud, Breguet, and others, manufactures ship's chronometers, regulators, turret clocks; finishes those French clocks so

well known all over the world, and whose movements come in the rough from Beaucourt, and whose artistic cases occupy many workers; also clock materials, such as anchors, mainsprings, hands, dials, electric apparatus, finished by watchmakers. Paris, besides being the great emporium for the sale of watches, delivered to the trade 250,000 clocks, 300,000 alarums and counters. The working watchmaking population numbers 8,000. It has now a school of horology, which bids fair to outrival its other French competitors.

Trois Fontaines provides enough watch glasses to supply the whole world, and that production was estimated at 1,200,000 francs. At Rosureux some turret clocks are made.

Saunier, after having deducted from Paris and Besançon the movements supplied by Beaucourt, Mont Céliard, &c., concludes his report in estimating the total watch and clockmaking production of France thus:—

	Francs.
Besançon	20,500,000
Paris	19,500,000
Some small centres, such as Trois Fontaines, Rosureux	1,500,000
Morez and neighbourhood	4,000,000
St. Nicholas d'Alièrmont	1,500,000
Beaucourt, Montbéliard, Seloncourt	9,000,000
Cluses	1,500,000
Total francs	57,500,000

General Notes.

PATENT-OFFICE.—The report of the Committee appointed in December, 1885, by the Board of Trade to inquire into the manner in which the Patent-office was carrying out the Patent Act of 1883 was published on Saturday, 5th inst., together with the evidence taken by the committee. The committee recommend that the practice introduced by the Act of 1883 of warning applicants of the existence of unpublished applications likely to conflict with their own should be dropped. In the unanimous opinion of the witnesses this practice had entirely failed, and it was calculated that the appeal of the provision would result in a saving of £300 to £400 a year. In the case of a patent being abandoned in consequence of a filed but unpublished description, the committee thought that the fees should be returned. The present system of examining applications appeared to the committee to be too elaborate, and they considered that it might be simplified by diminishing the excessive amount of supervision exercised. The alterations, it was believed, would set free some of the staff, who might then be employed in working up the heavy arrears in the publications of the office. The committee further recommend that any amendment required by the Patent Office should be supplied within a month, or that the patent should date from the time when it was so supplied, instead of from the time of the original application; and they advise that steps should be taken with a view of fixing a standard of qualification for the title of patent agent. If the proposed alterations are adopted, the committee suggest the appointment of another committee after a sufficient time has elapsed to test the working of the office.—*The Times.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Monday evening, at Eight o'clock:—

MARCH 14.—Adjourned Discussion on Mr. W. P. MARSHALL's paper on "Railway Brakes."

Wednesday evenings, at Eight o'clock:—

MARCH 16.—"Machinery and Appliances used on the Stage." By PERCY FITZGERALD. SIR FREDERICK POLLOCK, BART., will preside.

MARCH 23.—"The Living Organisms of the Air; the Effect of Place and Climate on their Prevalence." By DR. PERCY FRANKLAND. PROF. BURDON SANDERSON, M.D., F.R.S., will preside.

MARCH 30. — "Electric Locomotion." By A. RECKENZAUN.

The dates for the following Papers are not yet fixed:—

"Cottage Industries in Ireland." By MRS. ERNEST HART.

"Miners' Safety Lamps." By EDWARD H. LIVEING.

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MARCH 25.—"Indian Coffee." By FREDERICK CLIFFORD.

APRIL 29.— "Village Communities in India." By J. F. HEWITT.

MAY 27.—"Indian Tea." By DR. T. BERRY WHITE. H. S. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29.—"Colonial Wines." By RICHARD BANNISTER.

APRIL 19. — "South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

MAY 17.—"The West Indies." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

March 15.—"The Application of Gems to the Art of the Goldsmith." By Alfred Phillips. Sir George Birdwood, M.D., LL.D., K.C.I.E., C.S.I., will preside.

April 26.—"Ornamental Glass." By J. Hungerford Pollen.

May 10.—

May 24.—"The Importance of the Applied Arts and their Relation to Common Life." By Walter Crane.

These dates are liable to alteration.

Cantor Lectures.

The Fourth Course will be on "Machines for Testing Materials, especially Iron and Steel." By Prof. W. C. Unwin, F.R.S. Three Lectures.

Lecture I.—March 21.—Objects of testing materials.—Scientific and commercial objects.—Strictly relative character of ordinary testing.—Elasticity and plasticity.—Tension and compression. Behaviour of brittle and ductile materials.—Stress-strain diagrams.—Classifications of testing machines. Arrangement of testing machines.—Weighing apparatus.—Straining apparatus.—Knife edges.—Description of some typical machines.—Greenwood and Batley machine.—Wicksteed machine.—Grafenstaden machine.—Werder machine.

Lecture II.—March 28.—Maillard and emery machines.—Large machines without levers.—The Union Bridge Company's machine.—Methods of holding specimens.—Forms of specimens.—Measuring apparatus.

Lecture III.—April 4.—Tests of other kinds.—Shearing and crushing tests.—Tests of stone and cement.—Smaller testing machines.—Endurance tests. Relations between mechanical tests and chemical properties and modes of manufacture. Circumstances which affect the results of tests.

The Fifth and Concluding Course will be on "The Chemical Changes of Putrefaction and Antisepsis." By J. M. Thomson, F.C.S. Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 14...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned discussion on Mr. William P. Marshall's paper, "Railway Brakes."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieut. H. W. Seton-Karr, "The Alpine Regions of Alaska."

British Architects, 9, Conduit-street, W., 8 p.m. Prof. Kerr, "Some Observations on the Architect's Functions in Relation to Building Contracts."

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, March 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Alfred Phillips, "The Application of Gems to the Art of the Goldsmith."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture IX.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Colonel E. Maitland, "The Treatment of Gun-Steel."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. T. H. Elliott, "The Annual Taxes on Property and Income."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. Oldfied Thomas, "The Bats collected by Mr. C. M. Woodford in the Solomon Islands." 2. Mr. W. R. Ogilvie Grant, "A List of the Birds collected by Mr. C. M. Woodford in the Solomon Archipelago." 3. Mr. G. A. Boulenger, "Second Contribution to the Herpetology of the Solomon Islands."

Wednesday, March 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Percy Fitzgerald, "Machinery and Appliances used on the Stage."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Captain D. Wilson Barker, "Notes on taking Meteorological Observations on board Ship." 2. Dr. Hugh Robert Mill, "Marine Temperature Observations." 3. Exhibition of Marine Meteorological Instruments and Apparatus.

East India Association, Westminster Palace Hotel, S.W., 3½ p.m. Mr. J. S. Jeans, "How to Develop India."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. Herbert D. Appleton, "Rural Sanitary Authorities."

Thursday, March 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Alfred O. Walker, "Crustacea from Singapore." 2. Dr. George King, "The genus *Ficus*, with special reference to Indo-Malayan and Chinese species."

Chemical, Burlington-house, W., 8 p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Lecture by Mr. J. W. Bradley.

Parkes Museum of Hygiene, 74A, Margaret-street, Regent-street, W., 5 p.m. Dr. E. F. Willoughby, "George Varrentrapp, Sanitarian and Philanthropist."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. Max Müller, "The Science of Thought." (Lecture I.)

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Friday, March 18...United Service Institute, Whitehall-yard, 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. G. J. Romanes, "Mental Differences between Men and Women."

Civil Engineers, 25, Great George-street, S.W., 7 p.m. (Students' Meeting.) Mr. Walter C. Kerr, "The Manufacture of Raw Sugar." 2. Mr. Louis Martineau, "The Process and Machinery of Sugar Refining."

Philological, University College, W.C., 8 p.m. Rev. Prof. Skeat, "English Etymologies."

Saturday, March 19...Royal Institution, Albemarle-street W., 3 p.m. Lord Rayleigh, "Sound." (Lecture IV.

Journal of the Society of Arts.

No. 1,791. Vol. XXXV.

FRIDAY, MARCH 18, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list of subscriptions by members of the Society of Arts to the funds for the Imperial Institute since the list published in the last number of the *Journal*:—

	£	s.	d.
James Blackwood	1	1	0
John Christie	5	0	0
Major Lamorock Flower	1	0	0
Sir Penrose G. Julian, K.C.M.G., C.B.	30	0	0
T. Hayter Lewis	5	5	0
W. Lindley	20	0	0
John Shaw (Barnsbury)	2	2	0
John Smeaton	1	1	0
Julien Tripplin	1	1	0
W. H. B. Winchester, F.R.C.S.	1	1	0
Amounts previously acknowledged ..	2,012	13	0
Total............	£2,080	4	0

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

COLONIAL AND INDIAN EXHIBITION REPORTS.

The Reports on the Colonial Sections of the Exhibition, prepared under the direction of the Council of the Society, at the request of H.R.H. the Prince of Wales, Executive President of the Exhibition, and President of the Society, will be published next week by Messrs. Clowes and Sons, price 10s. 6d., to members of the Society, 8s.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1887 early in May next. This medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.
In 1865, to His Imperial Majesty, Napoleon III.
In 1866, to Michael Faraday, D.C.L , F.R.S.
In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.
In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.
In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.
In 1870, to Ferdinand de Lesseps, G.C.S.I.
In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.
In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.
In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.
In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.
In 1875, to Michael Chevalier.
In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.
In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.
In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S.
In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S.
In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.
In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.
In 1882, to Louis Pasteur, Member of the Institnte of France, For. Memb. R.S.
In 1883, to Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L , LL.D., F.R.S.
In 1884, to Captain James Buchanan Eads.
In 1885, to Mr. Henry Doulton.
In 1886, to Mr. Samuel Cunliffe Lister.

Proceedings of the Society.

SECTION OF APPLIED ART.

Tuesday, March 15, 1887; Sir George Birdwood, M.D., LL.D., K.C.I.E., C.S.I., in the chair.

The Chairman, in introducing Mr. Phillips to the meeting, said:—I have to congratulate the Society on his having kindly consented to prepare and read the paper for this evening—"The Application of

Gems to the Art of the Goldsmith." The firm of which he is now the head was founded more than fifty years ago by his father, Robert Phillips, who was the regenerator of art-goldsmiths' work in this country, when it had fallen into its deepest abasement, between the close of the great war with Bonaparte and the ascension of Queen Victoria to the throne of the United Kingdom. He spent most of his life, as his son has since done, in travelling throughout Europe for the yearly improvement of his art, to which he gave his entire devotion, and in which he gained the greatest distinction for himself and his country, earning the highest jury awards at the Great Exhibition, of 1851, in London, the Universal Exhibition of 1855, at Paris, and the 1862, London, and 1867, Paris, International Exhibitions. At the Paris Exhibition of 1878, he was a juror, *hors concours*. He received also the decoration of the Legion of Honour from the Emperor Napoleon III., and the Crown of Italy from King Victor Emanuel, as marks of their personal recognition of his unique reputation as an English art jeweller. His son, Mr. Alfred Phillips, in succeeding to his father's business, has been worthily walking in his father's footsteps, to the great gratification and pleasure of all who, like myself, have enjoyed the hereditary friendship of his family. But not only has a thoroughly practical and most interesting paper been prepared for us to-night by Mr. Alfred Phillips. Through the courtesy of several of his patrons, it will be illustrated by some of the noblest and choicest works that, during the past ten years, have been produced by Messrs. Phillips Bros. and Co. A rare delectation has, in this way, been provided for this evening's meeting, for which all present will, I am sure, be sincerely grateful to the Duke of Westminster, Lord Revelstoke, and Sir W. McCormack, and the other noblemen and gentlemen who have helped to make up the enchanting display.

The paper read was—

THE APPLICATION OF GEMS TO THE ART OF THE GOLDSMITH.

By Alfred Phillips.

My subject being one of the series in furtherance of the views, and I have a right to say the hopes, cherished by the Applied Art Section of this great Society, that the impetus of art application, wisely directed, be imparted to the various industries at present more or less flourishing in this country, I have had in constant view, while compiling the various facts which I now venture to submit for your consideration, the desirability of chiefly addressing myself to those applications fittest for the existing age and its requirements.

I do not propose, therefore, to recapitulate this evening an absolute chronology of the application of gems from the earliest periods, but elect to base my remarks with reference to the progress of goldsmithery upon the traditions which have survived from a comparatively recent period, namely, the early part of the 15th century, when precious stones came into liberal employment, finding their chief use as objects of personal adornment, distinct from the mystic and religious purposes to which they were applied during the earlier ages.

That gems were firstly so employed was doubtless due to their extreme rarity, inestimable price, and the consequent impossibility of their becoming articles of familiar commerce.

To the archæologist and the historian there is, without doubt, much that is vitally interesting in the use of precious gems and amulets throughout the early ages; and, so far as we are concerned to-night, there is this much which is indispensable to our argument, namely, the well known fact of the ever-increasing estimation in which gems have been held since the days of Moses, under whose rule we know them to have been used, whatever may be the controversy as to their form and nomenclature, as priestly adornments.

The breastplate of Aaron may be considered as a species of regalia, illustrating, as Crown jewels do, priceless possessions, beyond the purchase of individuals.

For identical reasons, the greatest interest must attach to the accession of Constantine, whose crown is accepted as the earliest instance of the jewelling of the chief symbol of empire.

From that time forward, we note the ever-developing luxury in the regalia of all civilised and indeed many half-civilised nations, and we may thereby admit the fact that so far, throughout successive centuries, the Crown jewels of European nations have furnished the chief outlet for gems of abnormal size and value. By the same token, barbaric nations have absorbed into their regalia gems of corresponding importance in their more primitive forms.

Again, archæologically speaking, nothing should surpass our interest in the engraved signets of Greece, at the remote period of 600 years before Christ, as well as, even at that early age, the production in rude form of some of the nobler gems, such as rubies and sapphires, besides those others which, from their inferior hardness, are classed to-day under the semi-precious category, as for

example amethyst, chrysolite, coral, amber, and opal.

Before abandoning the subject of early engraved gems, my own experience impels me to deny, in common with Lessing and other authorities, the existence of any admitted engraved gem of the early Greek period cut in a true ruby, for the simple reason that this finest quality of corundum cannot be satisfactorily incised by means of the *punctum lapidis* of the ancient engravers, which was nothing more than a lower formation of sapphire, of white or pale blue colour, said to have been found in the Island of Cyprus and imported into Greece under the name of adamas, for the primary purpose of gem engraving.

The *punctum lapidis* efficiently engraved the many gems of inferior hardness to itself, such as banded agates, sards, jasper, and the like, as well as the softer pellucid gems, as, for example, garnets, chrysolites, and formations of quartz.

It will easily be conceded that the diamond, if known at all in Pliny's time, was neither susceptible of manipulation by any art of cutting then existing, nor was it, in its crystallised form, applicable to the extensive intaglio engraving which the Greeks are known to have conducted. Without absolutely denying the treatment of the commoner qualities of sapphire by such a process in the earlier period, I should, with Mr. King, regard with extreme suspicion an incised work in fine sapphire ascribed to that age.

In support of my view, the ancient Greeks are known to have employed for ornament the true sapphire (Hyacinthus) in most cases, not only uncut, but barely shaped and crudely polished on the upper side only.

The two renowned gems, cut in sapphire, which once graced the Marlborough collection, belong to a later period, when the diamond was known as an incisor, the one being a portrait of Caracalla, A.D. 211, executed during the six years of his reign, and the other a head of Medusa, which conveys to me the impression of having been cut with the diamond. Both these gems possess the brilliant finish which only the diamond can impart.

Extravagant use was made of the gems and precious metals in Solomon's time, both in the secular cause and that of the magnificence of the temples and the priests. The gems, which had been more of mysteries than merchandise, were, in advance of the times, gradually becoming objects of commerce.

Large application was made of precious stones during the reign of Alexander, especially those of Indian origin, the use of which was no doubt prompted by the more educated craftsmen who followed in his wake through Eastern dominions.

The anxious student, desirous of tracing back to early sources the application of precious gems, finds himself continually checked by the utter ignorance of their technology which prevailed from the time of Moses to far beyond the time of the Romans possessing themselves of Asia and Africa. Then it was, as we all know, that the lavish use of precious stones, under Imperial rule, grew to be such an abuse that it was needful to frame laws curtailing that luxury, which was fatally contributing to the decline of a great empire.

Even under Constantine and his successors the technical acquaintance with the gems had scarcely improved, but they were better manipulated and more extensively applied.

A more reliable supply of gems had created increased familiarity with their general characteristics, and led onwards, by successive steps, to the assiduous attempts which were made during the Christian era to satisfactorily deal with the diamond as a finished gem.

At last, in the early part of the 15th century, this desideratum was accomplished. Diamond cutting may then be said to have inaugurated a great industry, while the real foundation had been thereby established for the application of finished gems, manufactured, if you approve of that term, out of the rough material, in something approaching the perfect development of to-day.

Before approaching the subject of the modern applications of the gems, it seems proper that some reference should be made to the general history of the ruling varieties which, in all ages, have constituted the staple commerce in precious stones. I refer, naturally, to the diamond, the ruby, the emerald, and the sapphire.

The so-called diamond of the Septuagint was no doubt the jasper. This may be the more readily conceded, practice having taught us that the diamond of Aaron's breastplate could not have been the diamond of our time, inasmuch as it was engraved. The engraving of the diamond, then absolutely unknown, is even in these days a necessarily imperfect process, savouring more of the abrasion of a gem than of its legitimate manipulation. Diamond engraving should be stigmatised as

the unprofitable accomplishment of the ruin of a gem, which, unlike its fellows, depends solely upon its unrivalled lustre, and should be condemned with all other misapplications of skill.

The diamond is deservedly the foremost of the gems. My subject being that of application, I cannot too soon remind you of the commencement of its general employment as a finished gem in France during the first quarter of the 15th century. The use of the diamond continued with unabated extravagance throughout the succeeding reigns of the French kings, especially that of Francis I., who not only encouraged its production, but the art of applying it to personal ornament.

All of us can feel how powerful an impetus was given to the art of the goldsmith when men like Cellini were welcomed to the courts of great monarchs, and there treated with friendship and liberality; neither is it difficult to ascribe a reason for the rapid spread of the jeweller's arts of Italy and France to the other countries of Europe, once the great example of their protection had been set by monarchs.

I pause for one moment to reflect upon the relative luxury which heralded the employment of diamonds in the 15th century. When we consider that in 1421 the revenue of England was under £56,000 of our money, and that of France apparently not in excess of that amount; when, in 1428, such a reverse as that we experienced at Orleans was sufficient to cripple our finances, striking the first blow at our power in that country, we need not ask ourselves why the sumptuary laws were soon after established.

We need not wonder that the luxury of an Agnes Sorel, or a Duchesse d'Etampes, could menace the resources of an entire dynasty, inestimable, for all that, as we have found the art traditions of those days.

Diamond cutting was practised in Paris, to a small extent, in the early part of the 15th century, but it is easy to perceive, from the specimens handed down to us, how primitive was the result, as compared to the magnificent manipulation of to-day.

As an industry already worthy of the name, it was conducted at Bruges towards the end of the same century, whence, we are told, the apprentices once more migrated to Paris, some of them also founding establishments in Amsterdam, the present centre of the diamond industry.

Cardinal Mazarin, a lover and enthusiastic collector of gems, protected and regenerated the art of diamond cutting in Paris during the second half of the 17th century. Since the year 1800, the Dutch industry may be said to have triumphed over all others. From that time diamond cutting has never been an important trade either in London or Paris, in both of which capitals, however, work of the highest perfection continues to be carried out.

Mr. Coster, formerly at the head of the diamond cutting industry of Amsterdam, considers that the unprecedented quantity of 2,500,000 carats of diamonds are now annually cut in that city. We must admit this to be an illustration of expansion, unequalled in any other trade since 1800, when the same city scarcely averaged an output of 15,000 carats.

There seems to be some justification for this gigantic estimate, inasmuch as motive power, now so easily obtainable, permits some 2,000 independent workmen to operate in their own homes, outside the sphere of statistical observation. From data, however, which I have collected in Amsterdam while compiling the facts for this paper, I find that the city is known to employ 8,000 skilled splitters, cutters, and polishers, producing an average during the last five years of 20,000 carats per week, or 1,040,000 carats per annum. At this moment it is believed that Amsterdam, in its regular workshops, is turning out 1,500,000 carats per annum.

It may truthfully be said of remarkable diamonds, up to the recent time of the Cape discoveries, that their value was vastly overestimated. It seemed as if, because they were far beyond the reach of ordinary buyers, there could be no harm in over-stating their value to an extent simply based upon their weight, but with little reference to the actual quality of the gems.

A glaring instance was Romé de l'Isle's estimation of the Braganza diamond, weight 1,680 carats, which he says was worth £224,000,000 sterling, or about £80 sterling per carat for the multiplicand of the square of its whole weight. This is aside from the fact that the Braganza has never been proved to be a diamond.

Again, the Orloff diamond of the Russian sceptre, weighing 779 carats, was, in the year 1800, supposed to be worth £4,854,728 sterling, although its actual cost was 135,417 guineas.

The monster rose diamond of the Great Mogul weighed 279 carats, and was valued at 380,000 guineas, and so on, until we come to the Regent, weighing 136¼ carats, and valued at 208,333 guineas, although its actual cost was half that amount. The most palpable

absurdity, however, is Dutens' valuation of that uninteresting gem, the Sancy, weighing 55 carats, which he states to be much above 25,000 guineas. I can find no contemporary estimate of a diamond of similar weight at more than £9,500.

The foregoing instances apply exclusively to the diamonds of the various East Indian localities, known in our markets as "Golkonda," which had been explored since the time of Alexander, and which had yielded the total supply of these gems until the Brazilian discovery in 1720.

The East Indian diamonds are by many authorities said to have been of finer quality than those of more recent discovery. While I do not share that opinion, I admit that they yielded a larger proportion of pure gems, and that they are both denser and harder than any others. I am confirmed by Thomas Collingwood Kitto as to their greater hardness, and by personal experiments with reference to specific gravity. Ellicott's exhaustive experiments in 1795, and those of Page, published in 1855, both prove the Oriental diamond to be of greater specific gravity than the Brazilian gem.

If one may judge by the superb old parures of Golkonda diamonds still extant, and eagerly sought after, the assertion may be accepted that East India yielded a larger per-centage of white stones. Indeed, it is well known that the various shades of yellow and cinnamon coloured diamonds were infinitely rarer before the opening of the Brazilian mines, and even then comparatively seldom, until the Cape mines produced an abundance of this particular class of diamond.

It would be impossible to frame a reliable estimate of the quantity and value of diamonds exported from India under British rule, as there was free trade in diamond seeking. The supply of Indian diamonds is now most uncertain, no noticeable quantity having been brought to this market for the last forty years.

The discovery of diamonds in Brazil in 1720 was followed in 1721 by the export of 173,000 carats to the European markets. As may be supposed, the value of diamonds considerably declined for a time, until the increased supply had, *ipso facto*, created relative application and demand. Shortly afterwards the Brazilian Government having assumed the working of the mines, the industry was successfully conducted until 1880, when the Cape diamonds, which were produced at a much smaller cost, reduced Brazilian mining to a minimum.

The present total export of diamonds from Brazil does not exceed 24,000 carats, of which it is estimated that 30 per cent. are of pure water, as against 20 per cent. of the same quality from South Africa, where, however, the crystals are found of much larger sizes than they ever have been in Brazil.

It cannot too emphatically be asserted that the qualification of "Cape diamond" applied to the South African gems as a term of reproach, should now and for ever be retracted by those persons who, knowing better, have been foolish enough to propagate such nonsense.

Cape diamonds furnish, to-day, fully 95 per cent. of the European supply, which alone is sufficient to uphold them in public estimation. It is true that colourless diamonds have been found, in the smallest proportion, in South Africa, but it is equally beyond dispute that large numbers of the whitest and most faultless diamonds are exported from the Cape, while the mass of material is conspicuous, whether white or coloured, for its brilliancy.

Disparagers of South African diamonds were usually interested in supplies of rough from other localities, and continue to fear that the public mind having been so industriously prejudiced against all denominations of African diamonds, purchasers would hold aloof if the goods were fairly represented.

It is not generally known that, during the first fourteen years of its career, the then most prolific of South African mines, the Kimberley, put out more diamonds than all the other sources of supply combined had produced since any record had been kept. Diamond mining commenced in earnest at the Cape in 1871, and developed with marvellous rapidity. Upon the authority of Mr. J. B. Finlason, chief inspector of diamond mines, I give the following statistics:—In 1880, the usual digger's claim, 31 ft. square, was equal to the unprecedented value of £32,000, readily realised. In 1874, the total shipments from the Cape amounted to £5,000,000 sterling. The Postmaster-General reports that between January 1st, 1874, and December 31st, 1877, the net weight of diamonds sent to England by post amounted to one ton. The Government returns of duty paid on diamonds, shipped from September, 1882, to February, 1884, amounted to £4,428,157, and weighed 3,617,226 carats.

In connection with the developing use of precious stones, but more especially the diamond, it is impossible to overrate the significance of the Table of Statistics given

below, for which I am indebted to the pains-taking courtesy of Messrs. Tiffany, the eminent goldsmiths, of New York.

These gentlemen have used their influence with the Government of the United States of America, in order to procure the most perfect form of tabular information, vouched for up to February 24 of the present year by the Chief of the Bureau of Statistics of the Treasury Debt. It will be at once recognised that America is the only country capable of furnishing such unquestionable evidence of the large increase in the application of diamonds since the Cape discoveries revolutionised the whole trade.

Not only are precious stones duty free in the chief European countries, but no record is kept upon which it would be safe to found even an approximate estimate of their consumption.

STATEMENT

Showing the value of Imported Precious Stones for consumption in the United States, together with the rates of duty on each kind, during the year ending June 30th, 1867, *to* 1886 *inclusive.*

Year ending June 30.	Precious Stones.					Imitation.	
	Not set.						
	Of all kinds, except rough or uncut Diamonds, after 1872, 10 per cent.	Diamonds, rough or uncut, free of duty.	Set, 25 per cent.	Diamonds (Glaziers'), 1867—72, 10 per cent.; after 1872, free of duty.	Diamond Dust (or "Bort") 1867—71, 20 per cent.; after 1871, free.	Not set, 40 per cent., except 1884—1886, 10 per cent.	Set, 30 per cent.
	dols.	dols.	dols.	dols.	dols.	dols.	dols.
1867	1,317,420	*a*	291	906	...	*d*	*d*
1868	1,060,544	*a*	1,465	484	...	*d*	*d*
1869	1,997,282	*a*	23	445	140	*d*	*d*
1870	1,768,324	*a*	1,504	9,372	88	*d*	*d*
1871	2,349,482	*a*	256	976	1,249	*d*	*d*
1872	2,939,155	*a*	2,400	2,386	89,707	...	2,733
1873	2,917,216	176,426	326	*c*	40,424	36,074	2,574
1874	2,158,172	144,629	114	*c*	68,621	161	4,644
1875	3,234,319	211,920	...	*c*	32,518	217	1,128
1876	2,409,516	186,404	45	*c*	20,678	1,098	1,310
1877	2,110,215	78,033	1,734	*c*	45,264	1,455	488
1878	2,970,469	63,270	1,026	*c*	36,409	1,335	1,091
1879	3,841,335	104,158	538	*c*	18,889	10,831	23,100
1880	6,690,912	129,207	765	*c*	49,360	1,898	12,118
1881	8,320,315	233,596	1,307	*c*	51,409	1,592	6,857
1882	8,377,200	449,513	3,205	*c*	92,853	1,433	11,818
1883	7,598,176	443,996	2,081	*c*	82,628	468	3,028
1884	8,712,315	367,816	*b*	23,208	37,121	88,618	*b*
1885	5,628,917	374,679	*b*	11,526	30,426	13,474	*b*
1886	7,915,660	302,822	*b*	8,949	32,316	27,574	*b*

a Included under "of all kinds."
b ,, ,, "Jewellery of all kinds."
c ,, ,, "Diamonds, rough or uncut.
d ,, ,, "Precious stones."

(Signed) WM. T. SWITZLER,
Chief of Bureau.

TREASURY DEPARTMENT,
STATISTICAL BUREAU,
February 24th, 1887.

I elect to refer conjointly to the ruby and sapphire, because, although no two denominations can more considerably vary in commercial value, they form the same body, differing only in colouring matter. The ruby, at any rate since 1700, has remained the most highly valued of the gems. A ten carat ruby, at that time, was worth £1,300.

I possess the record of the sale of a twenty carat ruby for £8,000, or considerably over double the value in 1700. About the year 1800, fine rubies of one carat were valued at about 10 guineas, but a six carat stone was recorded to have been sold for £1,000. It is not uncommon, in these days, to obtain £150 for a specimen ruby of 1½ carats.

From these facts it is easy to conclude that fine rubies prohibit current application, but it should be remembered that artificial prices refer only to gems of the true "pigeon blood" colour, untainted either by brown or violet. The high price of the ruby is likewise due to the uncertainty of the supply, and to the hoarding of the principal gems by Eastern princes.

It will be interesting to mark the influence upon rubies, once European control shall be definitely established over the Burmese mines. There are those who assert that these mines, scientifically worked, are destined to yield up a vastly increased quantity of this most precious material. If this were verified, rubies must diminish in value, but, on the other hand, a flourishing trade would spring up, as was the case with sapphires when the prolific discoveries in Kashmir reduced by 50 per cent. their market value, and admitted their application to jewellery within the reach of moderate incomes. Others affirm that the Burmese ruby mines, which have been uninterruptedly worked from early ages, are exhausted with reference to important gems, and that rarely is a stone produced of more than half a carat. My own experience shows this to be an exaggeration. On the interesting occasion of my report to the Indian Government upon the Burmese loot, I found, on the contrary, that a very large proportion of the rubies exceeded half a carat in weight. Of the quality, however, I must say that not one-hundreth portion was suitable for facetting, or for the European market. If such may be taken as representative of the Burmese supply, it seems right to conjecture that slight cheapening influence will be brought to bear upon rubies of high quality.

The sapphire, as I have said, is another coloured ruby. It is curious to note that blue-tinted corundum has always occurred in larger quantities than red. The sapphire, which once was next in value to the ruby, is to-day the cheapest of the major gems, and yet from its intrinsic beauty, and unrivalled blue colour, its disappearance would be to the art goldsmith a greater misfortune than that of either the ruby or the emerald, neither of which seem to have enjoyed the same sentimental association as the sapphire which, among many uses, we constantly find employed as an episcopa gem.

Commercially viewed, the sapphires, both blue and yellow—the last known as Oriental topazes—were almost of identical value about the year 1700. In fact, the value of all sapphires below 30 carats was even less than it is to-day. Here we have reference to parcels of stones averaging 6 grains at 40s. per carat, and to a fine 30 carat sapphire valued at £400. About 1830, sapphires begun to rise to exorbitant prices, which were maintained until about six or seven years ago, when the large quantities of rough brought from Kashmir and Siam literally glutted the markets, which scarcely yet can be said to have recovered their normal condition. If the supply be fifty times greater than at the beginning of last century, the demand created by the very cheapening of sapphires is practically certain to stay further decline in value. As an illustration of the plenteousness of sapphires, I recently received in one and the same consignment 1,300 stones, weighing 4,626 carats, the sterling value of which was £16,680, or an average per carat of £3 12s. 1½d.

The emerald, or *smaragdus* of the Latins, is one of the most beautiful, although the softest of the precious gems, easily fusible with borax into a colourless glass. The huge emeralds of Pliny and Theophrastus must have been either crystals of beryl – known to occur of a large size, and of which the emerald itself is the precious type—or else masses of green quartz. The true emerald occurs in crystals seldom over one inch in length. The Indian emerald has been applied both to signets and personal ornament alike in Ancient Greece, Italy, Egypt, and Arabia.

It must not be confounded with the so-called Oriental emerald of India, which is nothing less than a green ruby or sapphire, characterised by its sap-green colour, and, however curious as a gem, undeserving of the appellation of emerald.

The extraordinary rise in the value of this

gem since the year 1700 has known many fluctuations. The basis of valuation up to 1710 was one quarter of the price of table diamonds of same weight, or about 3s. 9d. per grain. A 10 carat emerald was worth about £160. From 1720 to 1780 the quantity of emeralds brought to the European markets had so largely increased as materially to diminish their value. At the end of last century rough emeralds were sold at the following approximate prices:—Inferior small, 20s. per oz. troy; medium small, 40s. per oz. troy; fine small, £8 per oz. troy; fine medium small, £10 per oz. troy; while the very best rough, in larger sizes, fetched only £15 per oz. troy, equal to 151½ carats.

Parcels of emeralds, now very rare, of medium colour, are offered at from £10 to £15 per carat. I have purchased small emeralds of good colour, within this month, at £6 per carat.

I should like to dissipate an idea frequently entertained by amateurs that the commercial value of many of the abnormal specimens of emerald on record is in proportion to their size, as, for example, the Duke of Devonshire's emerald, weighing 1,360 carats; Duleep Sing's emerald, measuring 3 in. by 2 in.; and a large sexangular emerald recently looted at Mandalay which, while its weight approximates to 200 carats, is distinguished by size but not quality.

The Minor Gems.

I regret that time this evening only enables me to sketch the outline of a chapter always dear to the art goldsmith. The application of the minor or æsthetic gems, as they are often called, has possessed a peculiar attraction to the craftsmen and purchasers of many ages.

It is true that from the times of early Greek art most of the gems enjoyed their mythology, but it is no less a fact that the important group of semi-precious gems, classed by their commercial value to-day, seem to have been those most involved in the legendary fable pervading the Christian era. The exquisite tones peculiar to these gems of lesser value establishes them as a separate category when compared to the magnificent or acknowledged gems. Their natural beauties could not fail to endear them to the artist in search of that which is best adapted to the harmonies of the *cinque cento*.

I do not think it possible for any gem to arrogate a greater art value, for example, than the amethyst, worn in the Middle Ages as an amulet and preservative in battle, besides being one of the pious or episcopal gems, invariably to be seen in the shrines, frequently centreing the bishop's morse, incrusted in the chalices of Italian and German art—in short, playing its part wherever it was desirable to impart serious beauty or dignity to the property of the Church.

To say that the amethyst, because it is only a beautiful variety of coloured crystal, should descend from its eminence as an art gem, would be to assert that which no artist could feel. If it were only as valuable as the sapphire, it is easy to believe that its popularity would be even greater.

Then we have the chrysolites, the topazes of various hues, the beautiful family of the garnets, Oriental varieties of which ranked with gems of higher order rather more than a century ago.

The peridot, which is worthy of a denomination of its own, other than its generic name of chrysolite, in spite of its softness, ranked with the gems from the 15th to the end of the 17th centuries, doubtless by reason of its perfectly artistic colour.

What is more beautiful in nature than the opal, and what more discreditable to the age of sober materialism in which we live, than the baseless conspiracy to attribute consequences of misfortune to the wearer. The Hungarian opal ranked with the principal gems when it was an article of familiar commerce in our markets, but now that a quite modern slur has been cast upon this lovely gem, it has naturally fallen in value to a considerable extent. Surely a gem which in ancient times was held in the highest repute, first for its beauty, and then because its very own mythology constituted it a harbinger of love and goodwill among men, should, in these days, triumph over the silliest of silly prejudices.

The selenite, or moonstone, deserves notice as a lesser gem of great beauty. There is hardly a stone admitting a greater variety of applications, the admirable softness of its tint enabling both coloured gems, diamonds and enamels, to happily be associated with it. I have sought to demonstrate this by the various examples I am submitting to you to-night of the the semi-precious gems in their applied forms.

Of the unmounted gems shown to-night, I would instance the unique specimens of beryls which recently passed out of my hands into the collection of a noble patron of art, to whom I am greatly indebted for the opportunity of displaying representative beryls such as no museum has acquired.

I am likewise indebted to Lord Revelstoke for the interesting opportunity of exhibiting to you the *saphir merveilleux* of Egalité Duke of Orleans, for many years an ornament of the Hope collection, and in addition to its remarkable history, a conspicuously beautiful gem.

Another great patron of the precious gems has enabled me to show you a remarkable parure of brilliants, assembled by me during the past year, the perfect brilliancy of which testifies at once to the quality and manipulation of South African diamonds.

Application.

At the present moment the beautiful lapis lazuli is sharing unmerited oblivion in common with onyx and, in short, most of the opaque and semi-opaque stones, upon which alas we had learned to rely no less than the great classic goldsmiths of Rome. We valued them beyond price as a consistent accompaniment of plain gold work, of that high order which lacks repose, in conjunction with the flashing gems.

When I look back to the magnificent results obtained by those golden ornaments at a comparatively recent date, I can but lament, whatever the cause, that classic goldsmithery should practically have become a joy of the past. Irresistably developing as is the patronage of the pellucid gems, I grieve to think there should no longer be sufficient large-heartedness to enable such priceless traditions to abide with us, in the once cherished form of sober and dignified personal ornaments.

Classic and, indeed, art goldsmiths' work, both that which was plain and that adorned by the various gems consistent with its character, was introduced into this country as an industry by my lamented father, Robert Phillips, about half a century ago. The travelling companion through Italy of Owen Jones, Digby Wyatt, John Gibson, and two generations of the Castellanis, he was not slow to perceive, with reference to his own art, the benefit likely to result from a radical improvement in the public taste for jewellery, either reproduced from antique or mediæval sources, or conceived in the spirit of those ages.

From that time, until some eight years ago, the good work proceeded, under the auspices of my father, an enthusiastic untiring revivalist, who accomplished his object with the disinterested feeling of an old master, rather than a man influenced by the ratio of its commercial success.

It must not be understood that this art of reproducing classical jewels, and accomodating them to modern uses, was heartily responded to at the outset of my late father's labours. It came as a surprise, not to the few cultured persons, but to the many who had never asked themselves why personal ornament should be endowed with a sentiment, a meaning, in short, a life of its own.

Emblematical ornament stood sadly in need of regeneration. Its introduction found the current taste of this country at a very low ebb, powerfully prejudiced, as it was, in favour of the utterly nondescript style which prevailed at that time and for many years afterwards.

I am sure that you will agree with me, that no more fitting occasion than the present could be found for the expression of my gratitude to Sir George Birdwood, our chairman this evening, for the valuable information he has imparted to me during the past seven years, with particular reference to symbolical jewellery.

The art of symbolism, which must not for one moment be dissociated from that of the goldsmith, indeed deserves a fuller share of recognition at my hands than circumstances permit to-night. Inasmuch as this interesting subject is being fully developed by Sir George Birdwood himself, in an enlarged work on the industrial arts of India, which he is now preparing for the Press, I shall not explicitly refer to communications which have been made to me in confidence. Briefly noticing Sir George Birdwood's views, which so far have been most ably stated in his already published works on Indian art, I may say that he considers jewellery other than symbolical to have no *raison d'être*, and to be unmeaning as mere ornament.

What is there which better conveys the influence of emblematical art than Shelton's able definition—that it is a picture imaging forth a truth or lesson by some figure or scene, a picture representing one thing to the eye and another to the understanding, and a device charged with some moral instruction. I have always held emblematical ornament to be the root of all decoration, and, therefore, attributable more or less to every style, however primitive or debased.

Such a belief should set every thinking goldsmith longing for the promised grammar of symbolisms. Sir George Birdwood gives an astronomical origin to nearly every conventional

design in ancient jewellery and indeed art generally, and even goes so far as to say, in which I cannot myself agree, that the breastplate of Aaron is of the nature really of a zodiacal palladium.

Once that prejudices had been partially conquered, success was not greater than had been anticipated. The apogee was reached at the Paris Exhibition of 1867, from which point a gradual, but uninterrupted, decline must be recorded in the popularity of jewellery of the Greek, Etruscan, and Roman types, but not so, happily, of those which were based upon the various schools distinguishing the Christian era.

The richest field of research afforded to the art goldsmith, and that which has never ceased to command allegiance, is the Renaissance. Upon this is destined to be founded all that is worth calling art, in the prospective periods of the goldsmith's craft. Here is the true basis of the art of the goldsmith, the enameller, the jeweller, and the chaser, all of whom merged into one man—in Cellini's person, the *facile princeps* of his craft. Here are the veritable treasures of tradition, to which the apprentice may turn with the certainty that his time will be well spent, his labours fruitfully repaid. The workman once capable of interpreting this school is master of his craft.

However capricious may have been the public taste since the inauguration of a style and method which might consistently be called the birth instead of the re-birth of art, with regard to the destinies of the modern goldsmith, support has never been absolutely wanting. Unreal or bastard styles have flourished meanwhile, one knows not why, but have as surely died out from lack of that imperishable quality of design pervading all decoration alike in the 15th and 16th centuries.

The revival of the Glyptic arts went hand in hand with those of the goldsmith, the one becoming the natural coadjutor of the other; the one, as it is to-day with the precious gems, creating and sustaining the demand for the other.

Enamelling upon gold, with all its beauties and mysteries of production, seemed, as if by magic, to have developed into a well-nigh perfect art, in potent and inseparable alliance with that of the goldsmith. Truly mysterious, as of the alchemists, were the secrets of the old enamellers. Each possessed the valuable fruit of his own discoveries, before manufacturers provided the vulgar supply of orthodox colours which has done so much to check the patient invention of the individual. Now, as then, to a lesser degree of course, we seekers promote individual experiment to our utmost power, devoting ourselves again and again to the improvement of our colours and the alloys of gold most favourable to their production, until it seems, that in this important direction, we have little more to learn.

If we except the enamel painting of Bordier's and Petitot's schools, as well as some of the conceptions, though not the process of Limoges, all good judges will admit that the technique of the Renaissance has not only been reached but surpassed within the last hundred years.

The specimens offered for your inspection to-night afford evidence of British development of translucent enamels, second to none which have been founded upon the almost invariable champlevé of the Renaissance. I do not propose to call your attention to existing technical processes, either of chemistry or application, involving as they always do the vested interests of proprietors who have expended much time and money in their cause. Our wish is to stimulate to useful sacrifices of time and talent those whose capability is unquestioned, and those who have never fairly tested their powers, or have preferred to rely upon the monotonous, all but automatic sources of supply, open to the current goldsmiths' trade of this country.

If the admirable combinations of enamels, with the technically imperfect gems of the Renaissance, constituted the delight of the exalted few who could possess them, and, to this moment, continue to be more eagerly competed for than any other class of precious relics, why should we despair of successfully founding upon them others as beautiful. Are we not backed by infinitely greater facilities, in every sense of the word, and by appliances, which had they existed in the 15th century, would perhaps have rendered our task hopeless.

Few, indeed, of our skilled craftsmen are artists by intuition, in spite of the golden opportunities afforded by South Kensington, with its unrivalled exemplary museum, its schools of art, and numerous beneficent dependencies. The valuable opportunity, therefore, now presenting itself to the Applied Art Section of our Society for encouraging competition by the skilled workmen, doubtless, will be heartily responded to, and may be confidently expected to confer a lasting benefit, firstly upon the operatives themselves, and next upon their employers. The primary condition of such competition, it goes without

saying, should be purity and originality of conception, based upon the characteristics of a given school, accommodated with taste and judgment to modern purposes. It would be well if such designs were capable of enrichment with the irreproachable gems of our age, and, if they tended, in many instancss, by the combination of beautiful translucent enamel to develop this comparatively neglected branch of the goldsmiths' art in England, encouragement in which, especially in the experimental sense, has absolutely depended upon one or two recognised masters only.

For myself, I may say that I have never ceased striving in that direction since 1862, although I have been annually reminded that the result of each year's labour, from a purely commercial point of view, could not have failed to be much more remunerative, had the similar amount been expended in the production of inartistic, mechanical ornaments, repeated *ad nauseam*.

The "Applied Art Section" needs by its labours equally to enlist the sympathies of workmen and employers, for is it not conceded under the only possible conditions of a great art industry, dealing with gems, and, therefore, inseparable from the consideration of capital, that the enterprise protecting and directing skilled labour into proper channels, is of far greater importance to the general community than the instrumental hand itself. For example, nobody suspects me, or other patrons of labour in a similar position, of creating, with our own hands, the art works which we call into existence. The educated master of this age, although he does not pass his life at the bench, according to the custom of his predecessors of the Renaissance, is, nevertheless, a technically practised man, who has been taught his trade in the workshop, and therefore knows what fine application is, and how to direct it. It would be both undesirable and impracticable for masters to sacrifice to manual labour time which, by the modern usages of commerce, they are compelled to devote to business, to study, and to journeying over the principal portion of the globe, in search, as we have been, of fresh treasures of application, and the further development of our art.

In offering prizes, therefore, for the competition of skilled labour, due regard should be shown to the masters who have given rise to the skill of the competitors, who, in a word, have created the demand for their work. This may possibly be by means of an honourable diploma, acknowledging their share of service in the good cause, or any but a pecuniary distinction, which they would value little, and consider more fitly bestowed upon the competitors themselves.

I seek to demonstrate to you, from the archives of my own house—and you have seen it verified by Falize and other pioneers of art in gold, perhaps more strikingly than by the Castellanis, the immortal disciples of ancient crafts—that it is the duty of every intelligent master to embrace all the meritorious schools of design. In training the apprentice, it has always seemed to me indispensable first to improve his acquaintance with an art by patient and textual reproduction; but once the head and hand are accustomed to their work, to encourage—in preference to the servile copy of a jewel, however beautiful—the creation of those which, while preserving the purity of style, are yet original conceptions; in short, such works as, under equal conditions of gems and their manufacture, might have been carried out in their respective bygone centuries. The accommodation to our wear of the grand schools of the 15th and 16th centuries, whatever the temptation of archæological considerations, should not suffer the use of gems of inferior quality or primitive manipulation.

Pre-eminent, therefore, among the applied gems of the *cinque cento* is the lovely but perishable pearl, the sole unaided gem (if gem it should be called), the solitary example of skin-deep beauty, incapable and gloriously independent of improvement at the hands of man.

Goldsmiths as a class, not only in this country, but also in France and Italy, appear to be growing unmindful of a great precept of the Renaissance, reposing in *them* the responsibility of creating taste for jewels of particular schools, which, alas! for want of a general determination, an understanding—in a word, a confederation of art and artists—are allowed, with all their valuable teachings, to lie dormant, or only to be regenerated by a very few of their number, in the cause of the small constituency, always faithful to art, and, like its great patrons of old, incapable of cherishing such glaring misapplications as bid fair, once more in our annals, to usurp the lead. All praise to our chairman to-night, and those with him, who first conceived the necessity for our Section of Applied Art, which embodies, as a pledge of success, the expert commercial element always ready, under the auspices of this Society, to assist in the furtherance of British art and commerce.

At this moment of universal depression in the staple trades of our country, of such giant industries as, in proportion to their own prosperity, are capable of reflecting either joy or sorrow upon the arts, and especially upon those arts of luxury to which we are now addressing ourselves, it cannot too well be understood, nor too fearlessly asserted, that English hands can and do produce as fine work as money can procure in any part of the globe. English workers are those, at any rate in connection with this trade, who most readily adapt themselves to work of a new or experimental character. Under such few of the masters as are encouraging them to depart from the beaten track, they are already adapting themselves to work which, ten years ago, would have been declined by them as the province of specialists abroad.

I am proud, as an Englishman, to say of the applications which are before you now, that they are initially conceived and carried out at home, and that sounder and better work could not be produced.

Having said, on behalf of my workmen, that which I am entitled to say, I beg leave to abandon to your competent judgment the outcome of my conceptions. It is deeply to be regretted, notwithstanding our advanced appliances in all branches of these trades, that whereas unlimited amounts of money are forthcoming for the purchase and preservation of the goldsmiths' work of the cherished centuries, not even an attenuated proportion of the sums so expended is now applied in pure encouragement of art in gold.

The pleasing exception, whether as a result of trade depression, or the apathy of art patrons, is to receive the commission to execute a fine work of art in gold, of the jewelled and enamelled type, such as might be considered a diploma, and one of the monuments of a house subsisting as we all do upon reputation and skill. The purchaser of these days desires apparently to limit his acquisitions to such articles as may, by the enterprise of certain masters, be found in a state of readiness. Artistically speaking, this is as unfortunate for the buyer as the seller.

The goldsmith, feeling himself not only cramped in the field of his invention by the dearth of commissions, but seriously hampered by the capricious tyranny of fashion, naturally only provides such articles as in his judgment, good or bad, are likely to find ready purchasers.

Sad is the reflection that the destiny of the goldsmith, both here and with our cultured neighbours of France, should be swayed by the fashions of a conspiracy of *modistes*, whose distorted conception of female adornment, by common consent, is allowed to sit in judgment upon a nobler and more enduring art. It is true that exaggeration of the size of jewelled ornaments has departed, I hope for ever; but, as a consequence of the *modiste's* veto, we are threatened, for the present, with the absolute eradication of jewels from female adornment. Indeed, the proportions of such ornaments as are to-day admissible by the strict regulation of fashion, are such as seriously to endanger the proper expression of art.

The staple articles of present adornment are the brooch and the armlet, reduced, if one would slavishly comply with the dictates of fashion, to such meagre limits, that a fair opportunity is not afforded the designer of expressing either the style or detail of his art. Earrings, for example, after thousands of years of unquestioned popularity, are menaced with nothing short of extinction. It is not an exaggeration to assert that there is not a single tradition of all the beautiful earrings, whether of Greek, Etruscan, Roman, or Renaissance origin, which can be reproduced in its entirety with any hope of popular sale.

Against better judgment, the goldsmith is compelled to trifle with his art by adopting, here and there, a section of the whole, so as to squeeze a semblance of the reality into the pitilessly small space allowed him. Bracelets of nearly all the antique types are at a proportionate disadvantage. But the despair of the artist reached its climax when the pendant was, for many years, ostracised by fashionable society. The graceful pendant, the veritable type of the goldsmiths' Renaissance, however often we may be forced to make a brooch of it, remains a pendant still. Happier days, at last, seem to be dawning for this most consistent jewel, now again reasserting its empire. Once more may the treasures of tradition be safely consulted, both the noble cap jewels and pendants of the Medicis or Valois, and the valuable legacies of Holbein, Zucchero, and Jehannet, those faithful translators of the goldsmith's skill. I have taken refuge in the royal and knightly collars of the Renaissance, wherein the grandeur of reposing art reflects much beauty upon imperfect gems. Even now, I am adapting them, as you see, to the throatlets of our dames and maidens, in the confident hope that, ere long, they must assert their superi-

ority, as vehicles for gems, over those senseless perversions which offend consistency. The general history of the arts, even without especial reference to this important chapter, shows that the career of the true goldsmith, always beset by difficulties, was never more so than now. The plethora of the precious gems, offering perpetual temptation to abandon art in simple favour of gaudy phantasy, is a great but by no means insurmountable difficulty. There is no reason why a constituency, numbering the millions of London alone, viewed as the centre of the art industries of Great Britain, should not support the worthy schools of her goldsmiths as well as jewellers. It seems evident that, if they, as parties to the contract, will only adhere to principle, London will not fail to respond, more and more initiated as she shall be into the mysteries of the crafts, by the grateful influence of her technical schools and art societies.

I will not for one moment discourage the liberal application of precious stones to articles of personal ornament, but I would have them consistently dealt with. In the interest of the wearer, as well as the producer, more regard should be shown to form and meaning. Why should diamonds not be massed, unaided by enamels or gold, in many of the forms of the Renaissance? Surely their effect as gems would not suffer, and the jewels so produced should command more patrons than others, however beautiful the material, which were unsupported by conventional art. It is both impossible and undesirable to attempt to check the empire of the gems, which have become the ruling destiny of our art, and, therefore, a condition of its existence. To those who would say that the splendid gems of this century contributed in a measure to the disturbance of traditional composition, I would reply that if such gems had been available in the earlier centuries, undoubtedly they would have been employed, much in the same fashion as the imperfect stones of these periods. Even admitting that such applications, while preserving their artistic character, might to some extent have been modified with especial regard to the use of such a gem as our plenteous diamond (then only in a partial state of existence), the inexorable fact remains, and its observance is a condition of our continued prosperity; that the gems of this age have become a paramount consideration.

Gems must be lavishly employed in response to universal demand, but should be applied with more and more judgment; with more and more feeling for the decorative principle, if the modern goldsmith aspire to a share in the glorious traditions which have elevated his craft into an art.

The scope of my paper forbids my entering into the arts in gold as dissociated from gems. By any foregoing observations I must not, therefore, be understood to imply a want of veneration for an art so really beautiful that, were its principles more generally observed, would not only deserve, but re-occupy, a foremost rank in public estimation. I do perceive the unconquerable love of that which is sparkling in the perfection of modern gems. Natural inclination to gaudiness demands, therefore, unexampled discretion on the part of the goldsmith, whose aim it is to steer the course imposed upon him by the 19th century, with its inexhaustible supply of gems at last within the grasp of all classes of society.

Now that the gems are absolute, there is something of despotism in their sway, which warns the goldsmith that prosperity depends entirely upon their judicious application. Let us therefore conspire to train the workman to a tasteful exercise of these combined arts. Philosophically we shall grieve over the attenuation, if not in years to come the virtual disappearance, of unaided art in gold. When we have lamented that its staunchest patrons, possessed by fashion, are now untrue to their old allegiance, we must even so acknowledge the potent attraction of the gems, alluring us to departure from arts which had the reason of their being in the forbidding price of precious stones.

I have said much in the cause of our craft, and of those who have upheld its dignity throughout many centuries, to the present day; but I should fail in the duty of a champion of the numerous British goldsmiths, who are honourable observers of principle in the manufacture of their wares, if I hesitated to say that the unjustifiable debasement of the precious metals applied to personal ornament, excepting only a few insignificant articles protected by the law, has grown to be a terrible abuse in this country. This practice, I am persuaded, has done more to check the development of our branch of British industry than all the causes of depression combined. By its agency an unfair competition has been allowed to arise between that which is fraudulent and that which, being of sterling quality, could, under paternal legislation, create for itself a market all over the civilised world.

The principled producer is absolutely beaten out of the market which he himself has created by the immoral trash tolerated and legalised by our defective law of Hall-marking. The want of a simple but stringent Act, compelling the Hall-marking of all articles of jewellery vended within the British dominions, is, firstly, inflicting ruinous injustice upon those manufacturers who, under the voluntary system, have never manufactured bad gold; and, secondly, has firmly implanted in the minds of foreigners frequenting our markets, the conviction that all British wares alike are made of the *or anglais*, or debased gold, than which they do not know of a more damaging qualification. It would be found, without doubt, whenever the constituted authority elected to grapple with this blot upon our system of manufacture, that the heads of all the foremost houses were unanimous in the opinion that such a guarantee, both to Englishmen at home and foreigners abroad, would alone suffice to bring about increased prosperity in every department of the trade.

It has been my privilege, as an advocate of compulsory Hall-marking in Great Britain, to address reports both to the Indian Government and, some time back, to the Goldsmiths' Company of London.

I sincerely hope that the day is not far distant when we may look forward to such an enactment as will not only confirm the good quality of home manufactures, but check the importation from the Continent of vast quantities of rubbish, produced expressly for our markets, of a quality so vile that it cannot re enter the countries of its origin.

DISCUSSION.

Mr. LEOPOLD PAM said he had listened with very great interest to Mr. Phillips's able paper, and had learnt a great deal from it.

Sir WILLIAM MCCORMACK said he had listened to the paper with much interest, and was glad to hear about the beautiful things of which Mr. Phillips had spoken so eloquently and well. Precious stones, as they all knew, had exercised great fascination over all peoples and in all ages, and there was not much likelihood, if any, that these fascinations would diminish. He thought those present, after inspecting the beautiful things which had been brought together that evening for their entertainment, could say that, in their own case, these fascinations were not likely to diminish.

Mr. FOSTER GRAHAM thought Mr. Phillips had opened up a very wide field for consideration. The question of improvement, upwards or downwards, was very important to anyone engaged in the manufacturing industry. He rather dissented from Mr. Phillips's views as to trusting to the workmen for any special improvement, believing that it was to the employer in art industries that they must look for improvement, not merely in the goldsmiths' art, but in every kindred art. If the employer was not technically, practically, and artistically educated, his staff of workmen would never become art-workmen. That, however, was a question which he would leave for others more competent than himself to deal with. He was also deeply grateful to Mr. Phillips for the many suggested ideas which he had imported into his paper, and which, when reflected upon, could not fail to lead to much improvement.

General BRINE said he had been in all the countries alluded to by Mr. Phillips, and had seen most of the gems which had been mentioned. The missionaries, who were the forerunners of civilisation all over the world, generally got hold of the gems, which they sold to travellers in order to support their missions.

The CHAIRMAN said he should not wish the discussion to close without justifying his opinion that "the breastplate of Aaron," was of the nature of a zodiacal palladium. Josephus ("Antiquities of the Jews," iii. vii., 5, 6, 7) by implication, frankly admits it. But he (the Chairman) had come to this conclusion not so much from the study of old world books as from long acquaintance with the people of India, and their traditional arts; and no one who had lived familiarly among them could ever for an instant doubt the original talismanic, palladial, phalacterial, prophylactic, alexipharmic, or therapeutic character not only of all jewellery, but of all decoration. Coloured stones, beautiful flowers, and fine feathers are not used in India primarily for ornament, but because they are sacred to some god the wearer would propitiate for his or her antidotal defence. Our whole pharmacopœia, including the British Pharmacopœia, has really originated in this way. The officinal plants were at first only 36; that is one for each of the 12 leading, and 24 subsidiary ("decani," "24 elders") constellations in the sun's path or "zodiacal" circle. In conformity with their number also, the human body was divided into 36 parts, and when men fell ill they gathered and used, not chemically and physiogically, but alexipharmically and therapeutically, some suitable preparation of the plant sacred to the divinity presiding over the limb or organ affected. Pharmacy means literally "enchantment," and "therapeutics, "the worship of the gods;" or cure by faith in the divinities of certain plants. Now that we have distilled them off as essences, and precipitated them as alkaloids, and can weigh and measure them out with the nicest exactitude, we despise "the prayer of faith," and even prosecute those who still put their trust in it. He was first led to suspect the zodiacal origin of

"Aaron's breastplate" from its obvious resemblance to the Hindu and Buddhist talismanic amulet known as the *nava ratna*, or "nine gems." This famous amulet, which is universally worn in India and Burmah, refers in India, in a secondary sense, to the nine poets [cf: the Pleiades or seven tragic poets of the Court of the Ptolemies] of the Court of the mythical Hindu king, Vi kramaditya, B.C. 57; but in its primary sense, the only sense in what it is understood by the Buddhists of Ceylon and Burmah, it refers to the seven planets, Saturn, Jupiter, Mars, Sol, Mercury, and Luna; the triform moon [cf: "the triple Hecate" (Tergemina] being represented in it by three gems instead of one. In Burmah this amulet is always shaped as a conventionalised eight-leaved lotus flower, typifying celestially the octagonal heaven, and terrestrially the octagonal earth; and is invariably set with the same gems, viz., the sapphire representing Saturn; the topaz, Jupiter; coral, Mars; the ruby, in the centre, Sol; the diamond, Venus; the emerald, Mercury; and the moonstone, the waxing, the pearl, the full, and the catseye, the waning moon or Luna. In India, on the other hand, the *nava ratna*, or *nao-ratan*, is always represented as a square, in fact, as a horoscopic square, obviously its most ancient form; while the stones with which it is set vary in almost every province; for, and in consequence probably of its wide association with the "nine gems" of the Court of Vi Kramaditya, its planetary character has become very much obscured among ignorant Hindus; as that of the horseshoe ornament with its seven gems, so much affected by horsey men, has passed out of popular recognition among ourselves; and that of the combined circle and crescent-shaped brooch, with its five pendants, has been forgotten by the Arabs and Turks, although it has descended to them directly from the Chaldeans, who were the great inventors of astrological mineralogy, and, indeed, of all ouranographical symbolism, whether spiritual or material. The vault of heaven, the womb of nature, with its included constellationary life, and, above all, the seven guardian planetary, and twelve guardian zodiacal divinities, is what is represented by the horseshoe, the *nava ratna*, and by the ark, and other similar symbols. The heaven above us is at once the celestial Mount Ararat, and the celestial ark which survives the deluge of time; it is the palladium and shield of the universe; and the horseshoe, and the *nava ratna* are magical images of it, that is talismans, and of the highest defensive and remedial advantage when worn as amulets, a word [cf: *hamal* "a bearer,"] which means a thing "borne" round the neck, arm, wrist, fingers, waist, or ankles, or on the head, or hung from the ears, nose, or shoulder [cf: *hamala* "a sword"]. "The breast of Aaron" was, in my opinion, just one of these amulets, only it was a zodiacal instead of a planetary palladium. Every one will now admit that the description of the Heavenly Jerusalem, in the Book of Revelation [xxi. 19-20] is derived from Chaldean astrology. Anyhow it is not original, but taken from the far older Book of Tobit. In this description, which I have long wished Mr. Phillips to reduce to terms of jewellery, for it would make a magnificent and most eloquent brooch, the 12 stones of "the New Jerusalem" are identical with the 12 stones assigned from the earliest tradition to the 12 signs of the zodiac. The number 12, like 7, is still everywhere in the East talismanic, and always refers to the 12 signs of the zodiac, just as 7 and 9 do to the 7 planets; the sacredness of the number 9, however, has another and older origin also, in which it is associated with the number 10, namely, in the 9 solar—that is, 10 physiological, afterwards distinguished as lunar, months of 28 days each of human gestation. The physiological month of 28 days, and the physiological year of 10 months, were far older than the astronomical month and year, as was therefore also the sanctity of the numbers 9 and 10. The great difficulty presented by "Aaron's breastplate" is in determining the stones of which it was made up. They were most probably absolutely identical with those forming the foundation of "the Heavenly Jerusalem;" but this cannot now be settled, as the tradition on the subject has long been uncertain, and every translation of the original Hebrew names of the stones is in consequence altogether conjectural. This difficulty will be at once understood by a glance at the tabular statement A on p. 452. The next difficulty is in assigning the 12 stones—which we should always call by their Hebrew names—to the 12 tribes they are intended to represent. Josephus says that the names of the sons of Jacob were engraved on the stones, beginning with the *odem* of Reuben and ending with the *jaspeh* of Benjamin, in the order of their birth; but as will be seen from the tabular statement A, this does not correspond with the order of the generally accepted Rabbinical tradition. In dwelling on this difficulty, and considering that the breastplate was most probably a similitude of the heavens, like the *nava ratna*, and that the distribution of the 12 tribes in Palestine, like that of the 12 cities in each of the Etrurian States, might be on a horoscopic basis, he (the Chairman) sought the clue to this distribution in the order of the encampment of the tribes of Israel in their trines, as given in Numbers ii.*; the trine of the East being Judah, Issachar, and Zebulon; of the South, Reuben, Simeon, and Gad; the West, Ephraim, Manasseh, and Benjamin; and of the North of Dan, Asher, and Naphtali. All this is set forth in the following tabular view, B, of the 12 tribes of Israel, in the camp order (Numbers ii *), showing its

* By counting the stones appropriated to the twelve tribes in the order of the tribes given in Numbers ii., but beginning with the south side, instead of on the east as in Numbers ii., and going round by east to north, and ending with the west side, we get the order of the stones in their four rows, as given in Exodus xxviii. 17—20. The order of the tribes in Numbers ii. is from east to south, and round by west, and ending with north. It will be observed that

A—TABULAR STATEMENT of the TWELVE STONES of AARON'S BREASTPLATE (Exodus xxviii, 17—20), showing their Hebrew names, the different translations of them; and the corresponding Tribes of Israel; also the twelve Signs of the Zodiac, and twelve foundation stones of the New Jerusalem (Rev. xxi. 19, 20). arranged in the sequence of the twelve breastplate stones and the corresponding tribes to which they are supposed to answer. The regular order of the Zodiacal Signs and stones, and of the foundation stones of the New Jerusalem, is shown by the numerals preceding them. The tribes of Israel are numbered under each:—1st, in order of birth (Gen. xxx. and xxxi.); 2nd, in order of motherhood (Exodus i. 2—4); 3rd, in order of blessing of Jacob (Gen. xlix.); 4th, in order of their "numbering" (Numbers i.); and 5th, in order of their encampment (Numbers ii.).

Rows of Stones.	Number of Stones.	Hebrew* Names.	English translation. Bible A.V.	English translation. Bible R.V.—margin.	Josephus, Ant., iii., vii., 5.	Generally received names —Rabbinical.	Suggested translation. Geo. B.	Corresponding tribes of Israel.	Corresponding sign of Zodiac.	Corresponding Zodiacal stones.	Corresponding foundation stones of New Jerusalem.
1st or South.	1	*Odem.*	Sardius.	Ruby.	Sardonyx.	Carnelion.	*Carnelion* = Sard.	REUBEN.‡ 1.1.1.1.4.	6. Virgo.	6. Carnelion.	6. Sardius = Carnelion.
	2	*Pidtah.*	Topaz.	Topaz.	Topaz.	Topaz.	*Chrysophrase topaz.*	SIMEON. 2.2.2.2.5.	10. Capricornus.	10. Ruby.	10. Chrysoprasus.
	3	*Bareketh.*	Carbuncle.	Emerald.	Emerald.	Emerald.	*Lapis lazuli.*†	GAD. 7.11.8.3. [Levi] 3.3.3.0.0.	2. Taurus.	2. Sapphire.	2. Sapphire, or Lapis lazuli.
2nd or East.	4	*Nophek.*	Emerald.	Carbuncle.	Carbuncle.	Ruby.	*not* Emerald.	JUDAH. 4.4.4.4.1.	5. Leo.	5. Onyx = sardonyx.	5. Sardonyx.
	5	*Sappir.*	Sapphire.	Sapphire.	Jasper.	Sapphire.	*not* Sapphire.	ISSACHAR. 9.5 6.5.2.	9. Sagittarius.	9. Topaz.	9. Topaz.
	6	*Jahalom.*	Diamond.	Sardonyx.	Sapphire.	Diamond.	*Jasper? not* Diamond.	ZEBULON. 10.6.5.6.3.	1. Aries.	1. Jasper.	1. Jasper.
3rd or North.	7	*Leshem.*	Ligure.	Amber.	Ligure.	Jacinth.	*Aquamarine* (or *Beryl*).	DAN. 5.9.7.10.10.	8. Scorpio.	8. Aquamarine = Beryl.	8. Beryl = Aquamarine.
	8	*Shebo.*	Agate.	Agate.	Amethyst.	Agate.	*Amethyst.*	ASHER. 8.12.9.11.11.	12. Pisces.	12. Amethyst.	12. Amethyst.
	9	*Achlamah.*	Amethyst.	Amethyst.	Agate.	Amethyst.	?	NAPHTALI. 6.10.10.12.12.	4. Cancer.	4. Emerald.	4. Emerald.
4th or West.	10	*Tharshish.*	Beryl.	Chalcedony.	Chrysolite.	Chrysolite.	*Chrysolite, i.e.,* "cats-eye."	EPHRAIM. 0.0.0.7.7.	7. Libra.	7. Chrysolite.	7. Chrysolite.
	11	*Shoham.*	Onyx.	Beryl.	Onyx.	Sardonyx.	*Jacinth.*	MANASSEH. [Joseph] 0.0.0.8.8. 11.9.11.0.0.	11. Aquarius.	11. Jacinth.	11. Jacinth.
	12	*Jaspeh.*	Jasper.	Jasper.	Beryl.	Jasper.	*Chalcedony* (or Agate?)	BENJAMIN. 12.8.12 9.9.	3. Gemini.	3. Agate.	3. Chalcedony.

* Of these names, *odem* means "red;" *bareketh*, "flashing" or "lightning;" *nophek*, "glowing,"—*i.e.*, carbuncle, "a little coal;" the rest are now meaningless. In all cases, the best clue to the stones really meant are the foundation stones of the New Jerusalem and identical Zodiacal stones.

† *Bareketh* is literally "lightning stone;" and as in the time of Moses it was the semi-precious stones that were most in vogue, I venture to identify the *bareketh* with *lapis lazuli*, the earthy-blue ground of which is flashed all over with lustrous metallic flecks and zig-zags.

‡ Josephus (Antiquities iii., vii., 5) states that the names of the twelve tribes of Israel were inscribed on the twelve stones of the breastplate in the order of the birth of the twelve sons of Jacob. This was possibly the original parallelism of the tribes and stones, but it must have been modified when the Levites were broken up as a tribe, and the tribe of Gad (the 7th in the order of the birth of their progenitor) took their (*i.e.*, the Levites) place in the mustering of the tribes (Numbers i). and with it the *bareketh* as their representative stone on the breastplate. Then Issachar, 9th in order of birth, takes the 5th place in the order of mustering, and with it the *sappir* ascribed to Dan by Josephus; and Zebulon, 10th by birth, takes the 6th place, and the *jahalom*, ascribed by Josephus to the 6th born, Naphtali. This rule of transposition fails, however, to explain the difference in the allotment of the remaining six stones among the remaining six tribes, as indicated by Josephus on the one hand, and, on the other accepted by Rabbinical tradition. The reason, probably, is that the division of the tribe of Joseph into the two tribes of Ephraim and Manasseh led to an arbitrary attribution of the 7th, 8th, 9th 10th, and 11th and 12th stones to Ephraim, Manasseh, Benjamin, Dan, Asher, and Naphtali, respectively. Of these, Asher, transferred from the 8th place of birth to the 11th in the numbering, keeps his stone, *shebo*; and Benjamin, raised from the 12th birthplace to the 9th in the numbering, also keeps his stone *jaspeh*. But Ephraim, put in the 7th place in the numbering, does not take the *leshem* stone of Gad, but the 10th stone, *tharshish*, of Zebulon; and Manasseh, put in the 8th place, does not take the 8th stone, *shebo*, of Asher, but the 11th, *shoham*, of Joseph, for which there is obvious reason. Dan, brought down from the 5th birth place to the 10th in the numbering, does not take the *tharshish* of Zebulon, but the 7th stone, *leshem*, of Gad; Naphtali, brought down from the 6th birth place to the 12th in numbering, does not get the 12th stone, *jaspeh*, of Benjamin, but is associated with the 9th stone, *achlamah*, of Issachar. This is inexplicable; but, after all, it creates a difficulty only in the case of three out the twelve stones of the breastplate. It might have been supposed that the supersession of Reuben as first of the twelve tribes by Judah, would have led to the appropriation of the *odem* stone to Judah; which would have completely harmonised the arrangement of the twelve tribes in their encampment with that of the twelve stones on the breastplate; but the tradition which ascribes the *odem* to Reuben, and the *jaspeh* to Benjamin, has never faltered, and may not be tampered with. It is remarkable that the encampment order of the tribes is, as would be said in India, right-handed; and of the corresponding stones in the breastplate, left-handed.

correspondence with the 12 signs of the zodiac in their quarterly trines (the diurnal trines East and West, and the nocturnal North and South), as elucidating the arrangement of the 12 stones of Aaron's breastplate (Exodus xxviii. 17-20), and its zodiacal symbolism. Here beginning with the south side, and reading off backward by the east and north to the west side, the Hebrew names of the 12 stones assigned by tradition to the 12 tribes, arrange themselves in four rows exactly in the order given in Exodus xxviii. 17—20. This explains the order of the stones therein given, and confirms the tradition which has always assigned the *odem* stone to Reuben and the *jaspeh* to Benjamin, the only two absolute identifications of the whole 12. It is to be observed also that the camp order of the tribe, when "registered" with that of the 12 signs of the zodiac, in their trines, as a horoscopic square; that is with Aries, Leo, Sagittarius, on the East, the post of highest honour; Virgo, Capricornus, and Taurus, on the South; Libra, Aquarius, and Gemini, on the West, and Scorpio, Pisces and Cancer, on the North; it will be observed that this "registration" places Judah in the sign of Leo, "the Lion of Judah." Moreover, the six favoured tribes occupy the six diurnal signs; that is, the dominant tribes appropriated them to themselves; while the six other tribes are found in the nocturnal signs; that is, were relegated to them. Observing this, it is impossible, irrespective of anything further to go upon, to avoid coming to the conclusion that "Aaron's breastplate" was a four-square figure of the heavens, and

B.

NORTH—LEFT HAND,
WATER, WHITE.

*	NAPHTALI (*Achlamah*) Cancer.	DAN (*Leshem*) Scorpio.	ASHER (*Shebo*) Pisces.	*
MANASSEH (*Shoham*) Aquarius.				ZEBULON (*Jahilom*) Aries.
EPHRAIM (*Tharshish*) Libra.		Diurnal Trines. Nocturnal Trines.		JUDAH (*Nophek*) Leo.
BENJAMIN (*Jaspeh*) Gemini.				ISSACHAR (*Sappir*) Sagittarius.
*	SIMEON (*Pidtah*) Capricornus	REUBEN (*Odem*) Virgo.	GAD (*Bareketh*) Taurus.	*

WEST—BACK,
AIR, BLUE.

EAST—FRONT,
FIRE, RED.

SOUTH—RIGHT HAND.
EARTH, YELLOW.

specifically a zodiacal palladium; which was worn as an amulet, and used as an oracle, after the manner of Dr. Dee's divining crystal. He (the Chairman) felt so convinced of this that he would arbitrarily translate the Hebrew names of the breastplate stones by those of the foundation stones of "the New Jerusalem," as given in Revelations xxi., in every instance in which there can be no reasonable doubt of the tribe to which they appertain. There were, however, wider and deeper reasons for his holding this view. Recent anthropological and antiquarian research had taught us that the religious sentiment exhibits itself at first in those degraded forms of polytheism which have been generically described by ethnologists under the term of animism, and which include such developments as fetishism, ætavism, or the worship of ancestors, and phallicism, or the worship of the reproductive powers of nature. Among the Caucasian races this low animist worship of the visible world was gradually raised to the higher forms of nature worship, of which the two principal are sabaism and polytheism. Sabaism, so termed from the Hebrew *tsebaoth*, "armies," applied particularly to "the host" of heaven, astral and angelic, is the worship of the 7 planets, and 12 signs of the

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the three tribes who lost the privileges of their prior berth, *i.e.*, of Reuben, Simeon, and Gad [in place of Levi], are in the camping order of Numbers ii., relegated from the east, the post of honour, to the south; and that the six more favoured tribes of the twelve correspond in horoscopic position with the six diurnal signs of the zodiac, and the six less favoured tribes with the nocturnal.

zodiac, and of the stellar bodies generally, and originated in the study of chronometric astronomy among the Chaldeans, who from the first incorporated with it the older phallic worship of their country. Its chief stronghold now is in China; but its influence is to be traced everywhere in the Old World, not only in the ancient paganism still surviving in popular superstitions and folklore, but in the abstrusest of modern ecclesiastical dogmas, for the Hebrews were altogether Chaldean by culture, if not in race, and in the sacred Scriptures handed down by them to their spiritual heirs in Eastern and Central Asia and in Europe, show themselves to have been inspired in every stage of their religious development by the supernatural conceptions and poetic imagery of Mesopotamian sabaism, which reaches its highest flights in the theologised astrology of the Book of Daniel and the Revelation of St. John the Divine. At first the Chaldeans would seem to have worshipped the stars generally and indiscriminately, and only gradually to have singled out the more remarkable "kenspeckle" constellations for special adoption, such as the Great Bear, the seven asterisms of which first gave to that number its immemorial holiness. Then, as they came more and more accurately to mark the succession of the months, and, later on, of the years, by the courses of the moon and sun, these ruling planets became successively the predominant deities of Sabaism. But the Chaldeans did not only regard each separate constellation, and, indeed, each separate asterism, as a distinct divinity, they also conceived of the entire expanse of the starry firmament above, with the green earth lying outstretched beneath as a corporate God, one and indivisible; the Macrocosm of Pythagoras, which, as their ouranography became perfected on the basis of the existing zodiacal and planetary system, they, under the existence of the phallic ideas still prevailing universally in the East, figured as an immaculate virgin mother; as a fruitful tree planted by the river of eternal life; as a holy mountain, the mountain of the gods (*i.e.*, the celestial Mount Zion, Mount Meru, Mount Olympus, &c., having each its terrestrial counterpart on earth); and as a heavenly city (Κρόνου τύρσις, *flammantia mœnia mundi*, "the Heavenly Jerusalem," &c.). This imagery, which if not suggested directly by mural paintings or mosaics, could have been conceived only by one who was a born master of decorative design, has determined all subsequent religious poetry and symbolism, and much ecclesiastical doctrine in the West, and every traditional motive of the ornamental arts of the East and West. It may be said, indeed, that there is scarcely a coherent ornament in art which is not derived from the Chaldean symbolism of the "Tree of Life," and of the 7 planetary and 12 zodiacal gods; and more than that, from their actual graphic presentment by the Assyrians and Babylonians. The veneration attached to certain numbers has its origin in the same source. The 7-fold planets,

"The lampads seven
That watch the Throne of Heaven,"

led the Chaldeans to esteem the unit 7 as the holiest of all numbers. Therefore they established the week of 7 days, and built their temples in 7 stages. Therefore also the city of Ecbatana was surrounded with 7 walls; and the temples and palaces of Burma and China are 7-roofed. Therefore 7 stars were given to the Pleiades; and 7 rivers had to be found for Vedic India, and 7 hills for Rome, and 7 mouths for the Nile; and the world is said in the Bible to have been created in 7 days; the clean beasts to have gone into the ark in 7's; and Balaam offered 7 rams and 7 bullocks on 7 altars; and the children of Israel daily marched round the walls of Jericho for 7 days; and Elisha bade Naaman wash in Jordan 7 times; and under the Levitical law every 7th day, and 7th month, and 7th year, was sabbatical, and a succession of 7 sabbatical years was followed by the year of Jubilee, which brought the sabbatical cycle to completion. Hence, as Josephus distinctly states, the candlestick of the tabernacle of Moses was 7-branched; and in the Book of Revelation the churches of Asia, &c., are 7; and there are 7 Christian virtues, and 7 deadly sins; and 7 sorrows of Mary; and 7 journeys of Christ; and 7 divisions of the Christian day; and 7 champions of Christendom. Likewise 7 wise men of Greece; and 7 sleepers; and 7 wonders of the world; and 7 metals; and 7 precious stones; and 7 notes of music; and 7 nails in a horse shoe; and 7 cuts and guards in fencing. The 12-fold signs through which the sun passes in a solar year made the number 12 divine. Therefore the sons of Jacob are 12; and there were 12 loaves of shewbread, which Josephus explicitly states "denoted the year, as distinguished into so many months;" and 12 brazen lions, as supporters of the "molten sea" of Solomon's temple; and 12 lions on the steps of Soloman's throne; and in the Book of Revelations the New Jerusalem has 12 foundations and 12 gates; and the "Tree of Life" 12 manner of fruits; and the woman clothed with the sun and moon is crowned with 12 stars. It is to be noted also that there were 12 tables of the Roman law; and that 12 fasces were carried before the decemviri who administered them; and that on the 1st of March each year the 12 Salii, or "dancing" priests of Mars, arrayed in embroidered tunics, perambulated the streets of Rome, bearing the 12 ancilia or shields dedicated the temple of Quirinus by Numa, as the palladium of the eternal city. It has never before been suspected, but they were certainly a zodiacal palladium; and I find that the embroidery on the cloaks of the Salii, as seen on an ancient gem, commonly figured in dictionaries of Roman antiquities [*vide* Rich], represents the sea-horse of Aquarius, and another symbolical figure which is not specifically zodiacal is certainly constellationary. The "fratres Arvales" were also 12. The palladium of British liberty is a jury of 12 good men and true; and of old every English archer

went into battle with 12 arrows in his belt, whence the saying:—"Every English archer carries [the lives of] 12 Scotchmen under his girdle." The right number of spokes in a cart-wheel is 12; and the hosiers' sign of a ram or lamb hanging from either a 12-spoked wheel, or a wheel with revolving legs for its spokes, is nothing but a similitude of the circle of the zodiac, with the sign of the ram represented in enlarged proportion, and naturalistically. Great reverence and awe also attaches to the occult power of the multiple of 7 by 12, that is to the number 84, which is still largely affected by the Hindus and Janias, and in certain relations even by the Mahomedans of India. From the earliest traditions of the Hindus, the *chaurasi*, or group of 84 villages, as a reduplication of the 84 constellations of the heavens, and analogous to our hundred or "cantred," has existed as one of the larger divisions of the land in Rajputana, the Panjab, and parts of the North-West Provinces. The 84 constellations are also represented by the *chaurasi* necklace of 84 beads, and by *chaurasi* palaces of 84 windows or columns, and in various other forms. The number 360 is also especially sacred among the Hindus, and Janias, and Budhists, because it is a multiple of the number of the 12 months of the year by the number (30) of the days of a solar month. Is it reasonable, then, to doubt that the number of the stones of Aaron's breastplate was suggested by the 12-fold signs of the Zodiac; and that it was in fact the zodiacal palladium of Israel. But why he (the Chairman) had gone into the matter at such great length was because he most strongly desired to recover the long lost threads of traditional symbolism in the ornamental arts of the Caucasian races. He did not forget what the followers of Goethe were always saying about art being its own self-sufficient end, and independent of all moral aim. But in reviewing the subject historically, he found that the highest principle in art was the didactic: and that the attainment of beauty is only the inevitable result of the successful artistic expression given to the teaching thus sought to be conveyed. And the advantage of going back to historical symbolism was that the hopeless striving after novelty and invention was destructive of all successful artistic expression in ornamentation, and forbidding to the true artistic temperament; while, on the contrary, nothing renders the attainment of artistic effect in decoration so easy as the use of traditional and familiar motives; especially if used with knowledge, and not ignorantly.

"A thing of beauty is a joy for ever."

As to symbolism, again: at least 5,000 years of speculation on the subjects of highest interest to our human nature are focussed in such ornaments as the *nava-ratna* and other talismanic Eastern jewellery, and in the gala trappings with which English cart horses are led forth on May-day; and surely even perfected material beauty receives an added charm, if it also be significant of the spiritual beliefs, and aspirations, and duties, in which men have always found, and ever will find, the only life worth living.

In conclusion, the Chairman proposed a cordial vote of thanks to the reader of the paper.

Mr. PHILLIPS, in reply, said that he rose with feelings of gratitude to return thanks for the kind reception accorded to him. He was proud to acknowledge that to his father's training he owed the measure of his success as an art goldsmith. To Sir George Birdwood, the chairman this evening, he likewise conveyed the fullest sense of his appreciation of the generosity shown in presiding over the present meeting. Sir George, who was one of the sponsors of Oriental art, would forgive him for saying that he had come to regard him as his sponsor and mentor too in many knotty questions, which he had ever been ready to solve with him, in the cause of Applied Art. To those who were, perhaps, unable to subscribe to some of his assertions, he would say that in such necessary divergence of opinion lay the true value of discussion. He had been most careful in stating only such facts as could be sustained, while his assertions resulted from the practical experience of several generations.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 16th, 1887; Sir FREDERICK POLLOCK, Bart., in the chair.

The following candidates were proposed for election as members of the Society:—

Acton, Tom, 36, Acton-st., Gray's-inn-road, W.C.
Cornell, W., Rydal-road, Streatham.
Huggins, J. Frederick, Lion Brewhouse, Broad-street, Golden-square, W.
Joy, Albert Bruce, The Studio, Beaumont-road, West Kensington, W.
Merrill, Edwin John, Thornhill, Wallwood-road, Leytonstone, Essex.
Mure, Arthur Henry, 2, Marloes-rd., Kensington, W.
Ritchie, Alexander, 4, Upper Thames-street, E.C.
Titmas, William, 32, Grafton-street East, Tottenham-court-road, W.C.
Watt, Thomas Rossiter, The Briars, Chislehurst, Kent.

AND AS HONORARY CORRESPONDING MEMBERS:—

Ferguson, Alastair Mackenzie, C.M.G., Colombo, Ceylon.
Ferguson, John, Colombo, Ceylon.

The following candidates were balloted for and duly elected members of the Society.

Eves, C. Washington, 1, Fen-court, E.C.
Frank, Julius Charles, 3, Newman's-court, Cornhill, E.C.

Nash, Isidor, 25, Whitechapel-road, E.
Parker, John, Nelson-villa, Hereford.
Travers, William, M.D., F.R.C.S., 2, Phillimore-gardens, W.
Unwin, John, Southport, Lancashire.

The paper read was—

ON SCENIC ILLUSION AND STAGE APPLIANCES.

By Percy Fitzgerald, M.A., F.S.A.

The subject we are to consider to-night has always been found interesting, as it is concerned with the entertainment and instruction of the civilised world. The art of scenic effect or illusion, with its accompaniments of scenery, decoration, and dresses, is really scientific, and founded on regular principles. To produce an appearance of reality objects have to be made unlike reality, according to fixed rules. This principle is, of course, common to other arts, such as painting and architecture, where what is intended to be seen at a distance, and by large numbers at once, is treated in a particular fashion. But in no department of life are such effects produced in so limited an area, and in so short a space of time, as on the stage. Streets, castles, cities, houses, are constructed in a few minutes, only to disappear and give place to structures as imposing. These changes are wrought by applying a few conventional principles which have really scarcely altered during a period of two centuries—just as in the case of the steam-engine, which, in spite of all improvements of detail, remains practically the same as in the days of Watt. At the present moment scenic effect is brought to the highest perfection; and it may be said that, whatever task is set to the scenic artist, if he be given resources in money and means, he is certain to carry it out.

Up to about thirty years ago, there was a regular system for scenery and of working scenery in the theatres of the world which had been in use for nearly a couple of centuries. Great theatres, such as the Scala, San Carlo, Bordeaux—as we can see from the published plans—were all fitted up on the same system. Over the stage was a series of flying galleries and along the sides a number of props or shafts, while in the roof was an elaborate system of drums or windlasses contrived to secure as much power as possible. These were connected ingeniously with a vast system of counterpoises, which ran in grooves down the walls. The moving of great weights in a theatre is contrived on this principle of balances, which ensures an even, equable, and certain motion, the counterpoises raising the machine, or object, and being merely controlled by the workman at his drum. The curtain, the drop-scene, even the vast opera-house chandelier, weighing many tons, are also so nicely balanced that a couple of men can raise or lower them. This power of the counterpoise was largely and ingeniously applied in spectacular plays which were in vogue twenty or thirty years ago, notably at the Gaietè, in Paris, or in our own pantomimes, when the engineers of the stage exhausted themselves in devising transformation scenes which took, perhaps, twenty minutes to unfold. The basis of all such displays are large platforms, or "equipments," as the French call them. They are the essential portions of every "transformation," and consist of a large stage rising slowly from below, and suspended by ropes and counterpoises, and so nicely balanced that a couple of carpenters can raise them, although burdened by a score of *figurantes*, each strapped to her iron. This is the principle which underlies all these effects, but it is infinitely varied, and there are even platforms upon platforms which rise in their turn after the first has arisen.

It is admitted that the English excel in all the mechanical arrangements of the stage. The *trappe anglaise* is an English invention, and is more thought of abroad than it is here. A spirit or a genius will of a sudden disappear through a wall; and this is arranged by the "English trap," which consists of a number of elastic belts of steel or twigs, like two combs placed with their teeth together. These are covered with painted canvas, like any scenic door. The actor flings himself against it; it lets him through, and then flies back to its original state. The same principle is carried out on the stage itself, when a pantomimist seems to pass through the boards, which close after him. The English trap, to be effectively used, requires a sort of courage and daring, as the effect depends on its being, as it were, recklessly done. The French players, as a rule, do not relish the process. It is this native boldness that ranks the English as the first pantomimists and "tumblers." The same courage is shown by the girls who are engaged in pantomimes, who suffer themselves to be hoisted up on irons some thirty or forty feet.

It may be interesting to consider for a few moments some of these mechanical *tours de*

force. The same principle is applied with little variation in all; I will then pass on to the remarkable changes that have recently taken place in the scenic system.

Few devices were more ingenious than that of appearing to give motion to the stage representing the deck of a ship. This was done at the French Opera, when the opera of "L'Africaine" was represented; and when, the word being given to change the course of the vessel, the stage was seen to swerve to the right or left. This was in great part an optical delusion, but the back portion of the stage, where the stern was exhibited, was a large platform nicely balanced, which swayed round as required, moving with it the gunwale of the vessel. The rude and time-honoured fashion still survives, without change, of producing the motion of the angry billows by a painted cloth, which a number of men or boys, lying on their backs, agitate with their arms. Up to this very night this venerable but effective practice is still pursued at one of our leading theatres.

There is a material peculiar to the stage, and invaluable to the scene-painter, of which profuse use is made at Drury Lane, at pantomime season. It is known as Profile. Large surfaces of this wood, about half an inch thick, are saturated in glue and put away to season. Out of this material is cut all those edgings to scenery, foliage, capitals of pillars, and the like, which formerly used to be cut out of pasteboard and nailed on. In the rough changes attendant on a great Drury Lane pantomime, this solidity is essential.

Conflagrations on the stage seem alarming things enough, from the thick volumes of smoke, the crimson glow, and the masses of flame, and many think the risk is serious; but behind the scenes it seems a tame process and perfectly safe. The effect is produced by burning in a pan a powder called "lycopodium," which gives out clouds of white smoke. On this is cast the glare of the lime light, through crimson glasses, and this gives a red, glowing tint to the fumes, revealed through jagged rents and openings. A huge bellows, like that of a forge, is employed to give a blast to the smoke, and, to appeal further to the imagination, there are falling beams, fire engines, &c. The important principle here indicated is that of using coloured glasses instead of coloured fires; it is becoming a great element in scenic illusion.

A new agent also is the use of steam, which is supposed to give the vaporous effect of clouds in motion, hitherto attempted by gauzes and painted cloths. This was first used at the Munich Opera-house, and is now elaborately applied in the Lyceum "Faust." A regular steam boiler or generator is fitted up under the stage; at the proper moment a number of cocks are opened, and the whole scene filled with vapour. Everyone will recall the first dramatic appearance of Mephistopheles' face through the clouds. This shows how every resource is being enlisted in the service of the stage. Electricity has also contributed its power, and blue fires are seen to flash along the blades of Faust and Valentine. The pure electric light, though it has been a good deal displayed in pantomimes, seems to be cold in its effects, and is not likely to grow in favour.

Nothing caused such mystery and astonishment as the well known apparition of the "Corsican Brothers," which advanced slowly, and at the same time kept rising, whilst no opening in the stage was visible. This was contrived by an inclined plane of two ledges or rails, starting from below the stage, and ascending at a gentle slope to the opposite side. A level stand was inserted at the bottom between the ledges, and on this the Corsican brother, or his double, took his stand. In the stage was an oval opening sufficient to let a figure pass through, the edges of which are lined with bristles or brushes, which makes the opening, as it were, fit close to the figure. This opening, however, is fixed between two planks or strips duly jointed, on the principle of those wooden shutters which roll up and down in front of shop windows. This flexible strip for the time appearing to be part of the stage, is wound on the same windlass or drum to which the rope that draws the stand up the inclined plane is attached, so that both the aperture and the stand advance together, and by the time the journey is completed, both have been wound round the drum. Simple as this appears, much ingenuity is required to make all work smoothly, and a hitch or jambing would be serious.

Formerly a large sheet of iron, hung up at the wing, was rattled noisily to give the effect of thunder, but the modern way is more terrible and effective. In the larger theatres the property room is placed over the audience; a sort of truck laden with round shot is wheeled along, which tilts over, and sends the balls tumbling slowly over each other, followed by a hollow, reverberating sound as they trundle along

the floor. For lightning a long tin tube with a spirit-lamp is used; a powder is then blown through, which takes fire as it passes by the spirit-lamp, and gives out a vivid flash. A more effective mode is to cut out of the scene zig-zag strips, in imitation of forked lightning; these are covered with varnished calico, and painted, and a light flashed behind. Rain is imitated by the rolling of peas in a long tube; wind, by revolving a roller against a rough cloth. The most absurd attempt at illusion, and which is still retained even at first-rate theatres, is the attempt to represent any crash, such as the breaking open of a door, or falling downstairs. This is invariably done by an extraordinary sound of springing a rattle with perhaps a heap of broken glass emptied from a basin. Battles on the stage are common enough, and cannon and muskets are discharged with good effect, a sort of drawing-room cartridge made of phosphorus having been invented specially, which on explosion leaves no trace. In aid of a general engagement there is a substitute in use in country theatres, consisting of a cylinder, studded with knobs, which, as it revolves, strikes against projecting flaps of stiff wood, bending them back and then releasing them, much after the principle of a gigantic rattle. This produces that terrific din as of a volley, which gives such a frightful emphasis to the detailed explosions. Great caution, however, has to be observed in the use of fire-arms, and in the French theatres the ramrod is always fixed by a chain to the wall, as, in the hurry, it is often forgotten in the gun. The effect of ice breaking up on a vast sea has been successfully pourtrayed, by a curious illusive principle. Strips of whitened canvas representing the ice were slowly drawn away to the right and left, revealing the waters underneath, which in their turn were represented by sheets of perfectly black bombasine, not green or blue, as might be expected. The effect produced on the audience was entirely owing to the contrast with the glaring white ice, which caused the waters below to look of an inky hue. The result was founded on ocular illusion, and, therefore, on true scenic principles, and its success was in proportion.

The carpentry and joinery of scenes is scientific, and has principles of its own. Nails are not used, and all joints and corners are secured by wooden pins. Iron nails would soon loosen, and the strain split the wood. Scene-men acquire great deftness in moving or shifting these huge frames, which are often seme forty or fifty feet high, keeping them perfectly perpendicular as they move them.

I might dwell long on these and other mechanical devices; but the principle varies little in most cases. A more important and interesting matter is the curious change and complete transformation that has ever taken place in scenery within one generation.

It may be conceived that ingenious men, seeing the old and rather clumsy character of scenery, should have often tried to introduce a purely scientific system. When the Paris Opera was being built, a crowd of inventors came forward with various schemes. One M. Raymond submitted models of a kind of panoramic structure, which filled the back of the stage in a semi-circular fashion, thus doing away with side scenes. The sky was formed by a hemisphere, so that the whole had the appearance of the apse of a cathedral. These hemispheres moved something after the fashion of the cowl of a chimney pot. On this framework the various scenes were painted, and could be moved around as change was required. The difficulties of this scheme were obvious—the least of which was the certainty of catching or "sticking," the impossibility of putting away the semi-circular scene that had been removed, while all the supporting ribs would be certain to imprint blackened marks on the canvas. As borders were abolished, the problem of lighting would have to be met.

Foucault, the well-known devisor of the pendulum experiment, suggested a semi-circular back scene, with a series of semi-circular side scenes in front, and it was supposed that all these curves would blend into each other, and present an indistinct idea of distance. It was found, however, that it was necessary to be exactly in the centre of the house at a point where all the converging lines would meet the eye. In every other part all seemed awry as it were, and the effect was completely lost. In short these ideas were found Utopian, and though premiums were offered and every inducement held out to men of science and ingenuity, the result is that the most costly of modern theatres—and it cost a couple of millions sterling—retains the old-fashioned system.

The difficulty of dealing with the floor of the stage, banks, hills, flights of steps, &c., which are so common in operas, also exercised the inventors. For the new Paris Opera House some ingenious plans were offered, and one was seriously entertained. This was of

dividing the whole stage into small platforms, each supported on pistons moving up and down in hydraulic presses. A lever, put in motion by the stage manager, would thus elevate or depress any sections of the stage to the height or depth required. This was ingenious, and it was elaborated with care and all but adopted, but the objections were found insuperable. The space below the stage was lost, being filled with pumps and apparatus, there were nearly a hundred pistons, but the real danger was the almost certainty of some part of the machinery getting out of order. The system was actually adopted at the new Vaudeville, but never came into use.

In the Madison-square Theatre, New York, there is an odd invention in a double stage, one under the other, which descends and ascends, much like a hotel lift. Thus, when one act is going on, the portion below is being arranged for the next, and when the drop scene falls the stage ascends and gives place to the next shelf. This apparatus weighs many tons, but the whole is so well balanced by counterpoises, that four men at the windlass can move it. But this bizarre idea is more ingenious than practical: there must be an interval between the acts to give the audience rest or repose, and this interval is nearly always quite sufficient for the re-arrangement of the ordinary stage. Another New York novelty, adopted at two theatres, is the placing the orchestra over the stage. At the Lyceum, in that City, the orchestra gallery is suspended in the air, between the drop scene and the curtain, and when its functions is over, is drawn up into the clouds. It must be said that nothing is gained by these fantastic arrangements, save a sense of novelty.

With the old system of flats, side scenes, and borders, we all realise how a change of scene used to be effected. A shrill whistle was heard, a series of grooves working on hinges were let down for the side scenes to run in, one set was drawn away and another pushed forward, whilst the back scene, divided into two portions, met in the centre with a sharp report. In most foreign theatres, the side scenes work in slits in the floor of the stage, and really travel over the mezzanine floor below, on what are called "chariots." Mr. Fechter, when he took an English theatre, introduced this system, as well as the sunken footlights, which are still retained. This arrangement of borders and side scene is still necessary in large theatres with vast spaces aloft and at the sides, which it is necessary to cover in, and which it would be too costly to do by the enclosing scenery now fashionable. This old system may still be seen in full work at the Olympic Theatre.

The first change in this system took place some fifteen or twenty years ago, when what was called "built-up scenery" was introduced. This unhappy innovation, thought to be an improvement, has done much mischief, both to the form of the play and dramatic interest, as well as to the sense of illusion. Owing to the bulk and ambitious character of these vast structures, it was impossible to change the scene often, hence each scene was an act, or else there was a profuse use of carpenters' scenes. The elocution and utterance of the actor suffered, his voice having to struggle with these huge and impeding constructions. At this period - only a few years back—whole plays were written to exhibit what was called a sensation scene, such as a representation of Charing-cross or Waterloo-bridge, with which audiences were enchanted. A play which depended on one of these trophies was necessarily poor, and it may be said plainly that such things have no connection with dramatic interest. All this meant the introduction of what is called realism on the stage, but what Lamb has so often enforced in reference to realistic character applied equally to scenery. We go to the theatre, he says, to escape from real life, not to bring it there with us, and in this view scenery should be as general as possible. Indeed, it always seems that, in proportion as the scene appears of this solid character, it enfeebles the airy and romantic character of the play. The serious objection to these elaborately built up architectural scenes is, that the rules of perspective and distance cannot be properly carried out. A range of realistic pillars, for instance, can be graduated in size and shortened, as they are farther off, so that the last shall be about two or three feet lower than the first. But such shortening in nature is not so abruptly done, and requires long distances, and on the stage the scale of the human figure cannot be thus arbitrarily abridged.

The ingenuity of modern scenic artists, in obedience to the wishes of the dramatists who desired a freer hand and felt cramped by being allowed only one scene in each act, next discovered a mode of changing these heavy sets in sight of the audience. This consisted in, as it were, turning them inside out while removing them, or else in turning the back to

the front, or drawing over one portion to the right so as to uncover the left-hand side. There are the gravest objections to this monstrous and cumbrous system. It is, in the first place, a most effective destroyer of illusion and dramatic effect, for after such a grotesque mode of change, with wheelings, grumblings, and volleys, the mind is quite perplexed with speculations as to what will be evolved out of these extraordinary gyrations; and to see a tower travelling on castors about the stage, and then turning right round, so as to exhibit a portion of the interior of a room, completely destroys all idea of dramatic propriety. The expense, too, of these gymnastic scenes is immense. Indeed, the extraordinary shifts and contrivances to compass this *changement à vue*, as the French call it, are truly grotesque. Not long since, at a leading West-end theatre, when a room was to change to a village green, after the tables and chairs had been drawn off in the usual way by cords, the large carpet might seem a difficulty, but it had been attached to the bottom of the ascending ball scene, and ascended with it.

With all these realistic displays the result has been a real loss of illusion. The light has become so profuse and glaring that all distance and mystery is lost, while the scene painters are compelled, in self-defence, to make their colours as fiery as possible. There is one theatre, however, where this feeling and mystery and illusion are carried out under the most poetical conditions. I allude, of course, to the Lyceum. Here we find a most accomplished artist, Mr. Craven, worthy descendant of the line of Beverley and Stanfield. The Lyceum system is worth considering for a few moments, as here is cultivated the sense of illusion in the most perfect way.

The system in use there, like most systems of the day, is an eclectic one, it selects and combines what will best carry out its purpose. It is a mixture of the old borders and flat systems with the built-up one. To this again is added a profuse use of modelled effects. There is a great advantage to start with in the beautiful and well-designed stage, well suited to set off the pictures of the artist, which are most welcome to the eye. But the charm is in the judicious control and subordination of all these agents to the general effect.

There is also another element which is used with extraordinary effect, namely, an elaborate system of varied lights which is brought in aid of the colouring. These are apart from the usual gas battens and lengths; and are contrived by a complex series of coloured glasses which are changed and experimented upon till the effect is found. Mr. Craven lately explained some of his views, and they are interesting. "A particular art of painting," he said, "has to be applied, by which seemingly hopeless combinations are made to appear as one harmonious whole—giving height, breadth, distance, space, light and colour; the effects of day, night, wind, and rain; the general hurly-burly of the tempest, and the calm of the mid-day sun." In the scenes for "Romeo and Juliet," at the Lyceum, and afterwards in "The Mikado," he succeeded in portraying a bright, clear, blue sky by the introduction of an entirely new colour; with the result was light, air, and colour.

Here this subordination of detail to the general effect is carried out in every direction. The lightning is subdued so as not to reveal details, the changes of scene are effected in obscurity; the painting and colours are in low rich tones so as to throw out the figures. Every one will recall the original and strikingly effective use of the gauzes for supernatural effects in "Faust." Another element is the abundant use at this house of modelled architectural pieces, such as statues, sculptured pillars, and the monumental cathedral in "Faust," and the elaborate temple that was exhibited in Tennyson's "Cup," the pillars of which were adorned with classical figures in high relief, all which prodigies, I may say, were wrought in pasteboard; that is, the design was moulded in plaster, and sheets of paper were pasted over it until the desired thickness was reached. Thus was ingeniously secured all the effect of stone—in a material excessively light and portable—and enduring any amount of what is called "knocking about." Beautiful and satisfactory as these results are, they are not without drawbacks. This elaborate modelling affects the coloured portions by contrast, and imparts a flatness to painted details. The opening scene at the Savoy Theatre (also Mr. Craven's) represents in the most perfect way the last shape of scenery. Here we have sky border, and building up, and coloured lights, and modelled portions, and all with the most brilliant and satisfactory result. It requires, however, extraordinary efforts to unite these systems, which are really irreconcilable, as anyone can see who in a drawing-room scene notes borders used as a ceiling in combination with side walls, for the edges of both cross each other at a right angle.

A clever Frenchmen, the other day, when

shown some triumph of scenery, exclaimed, *Voilà le dernier mot*. He was promptly assured by the manager that, "in scenery there is never the last word—but only the last but one." That is, the scene painter engages, as it is called, "to beat any previous record." But this is surely an unsatisfactory state of things for the public — who already gaze, with but sated eyes, at some spectacle that has cost enormous quantity of time, thought, and money to prepare. As I said, there should surely be something scientific in this great art of the scene – some principles which should fix the proper province of scenic effect and illustration. And I propose, before concluding, to formulate a few of these principles.

The first point would be to settle clearly what is the true relation of the spectators to the action on the stage. The popular notion is that they are in the position of Asmodeus; the side of the house being, as it were, removed for their benefit; that through the great arch we see a room, a street, a castle. But this is not consistent with the dramatic theory, which assumes that the audience, though at a distance, is privy to all that goes on. The foundation of every drama is, that the audience and author are in each other's confidence, for when the author attempts a surprise on the audience it is always resented. The situation of the audience is, therefore, that of an interested person on the stage—and the fourth side of the room is really behind the audience. Supposing this view to be acceptable, the peep-show idea of the scene, that is, of the audience looking into another world through an arched opening, will not hold. Then we may ask, "what is the scene" it looks on? How is it defined and limited?

By existing custom it seems to be held that this should be a complete representation of the locality. If it be a room, a complete room; if a square in a city, it must be an entire square; if the outside of a house or castle, it must be nearly all castle. Yet in real life, when some critical incident occurs in, say, a drawing-room, or in the open street, the spectator, absorbed in the interest of his business, takes in, not the entire superficies of the room, but only the immediate background or surroundings of the incident, the zone, as it were, of a few feet around the personages. This is sufficient, and the dramatic absorption allows of no more. There is an admirable passage in Lamb's Essays, where he is criticising one of Martin's great pictures filled with architectural details and innumerable figures, and where he sets out the true principle. "Not all that is optically possible to be seen," he says, "is to be shown in every picture. In a day of horrors such as Martin's 'Belshazzar's Feast,' the eye should see as the actual eye of an agent or patient in the immediate scene would see, only in masses and indistinctness, only what the eye might be supposed to see in the doing or suffering of some portentous action." Not all that is optically possible is to be shown in a picture or a scene! Most impressive words these. It will be asked, how is this excellent theory to be applied in practice. The answer is that it has been applied, and that the old system of flats and side scenes was in a rude way based upon it. A room, for instance, was there, only so much of the room as was concerned with the action, and this the whole system helped to indicate in the best manner. The very method, as it is called, of "coming on" or "coming off" the scene illustrates, under the modern system, every step of an actor's progress. All that is "optically possible" must literally be accounted for; he must walk to the wing, open the door, pass through, and close it. But by the old system the player went off or came on the scene—that is, he passed, as it were, from the zone of action, and merely disappeared at the wing. In real life it would be the same, *i.e.*, were we looking on at a dramatic crisis we would take no note of door, or passage to the door, all that would come within our ken, was that the person had left the scene of action, the rest was too minute for observations. All this helps to make scenery general! In our modern system, this attempting to exhibit all that is "optically possible," especially in built-up structures, leads to absurd results. While the area is constant and invariable, there must be a perpetual alteration of scale in successive scenes. The same space serves in one, for the interior of the cabin, in the next for the interior of a palace, or the elevation of a built-up castle, or for a large square or market-place. This is the result of minute imitation or reproduction of outside objects. This, to be at all faithful, would require elasticity of space. But in the old system, viz., the dealing scenically with the space only immediately round the performers, we have a factor that is always constant, and a scale that does not change. At the same time, the scenic artist who confines himself to canvas has boundless resources for his perspectives and distant prospects on the flat,

and there is no danger of the scale being disturbed by the figure of the actor. I have seen Italian scenery painted on this principle with the most startling results.

I can fancy, however, that in time we will revert to this wholesome system, where the relief and distances will entirely depend on the skill of the painter. It is indeed possible, as a painter knows, to make a distinct art of this simulation of raised surfaces. Foreign artists make this imitation of relief and distance quite a study, and in Italian churches we see figures in relief so high as to deceive the eye. At the same time it would be impossible to revert to the old baldness of flats and side scenes without due modernisation. The glare of light in which our stages are bathed is fatal to all illusion, it reveals everything, the planks in the boards, the texture and creases in the canvas, the streaks of the paint. The light, playing on the edges of the side scenes, would show us that they were mere screens, but with subdued lighting, and low, rich tones and colours, the edges would be softened away and all made into one whole.

This idea, that the scenic decoration should be bounded by the zone of dramatic interest, is curiously supported by the old method of lighting. It is a fact that in Garrick's time the stage was lit by no more than four chandeliers, with a half dozen candles in each, hung over the heads of the actors, besides a few lamps and candles at the wings; thus the light was thrown mostly on to the faces of the central figures, and the largest part of the stage must have been in obscurity. I fancy that by this system of a dark background the figures must have stood out with surprising brilliancy; the eyes of the audience must therefore have been directed to the illuminated portion, instead of, as now, being distributed by the universal effulgence. We are so accustomed to the light being cast upward that we now cannot conceive them in any other position; yet the light being thrown downwards, as in real life, the unimportant legs being left in comparative shade, it must have had better effect. Every one at the present time, sitting close under the stage and looking up at the actors, is struck by the unpleasant and unnatural look of the human face and figure divine seen under this illumination; for thus the forehead, top of nose, and lips are all in shadow; the teeth, instead of being shaded by the upper lip, come into full glare. M. Garnier, the architect of the new Paris Opera House, pleads for the footlights, and thinks it adds an air of youth. But relief of light and shadow makes up half the pictorial effect of life. We can see from the old theatrical paintings in the Garrick Club that the apartments and scenes in which the player moved were lit, as in ordinary life, with visible lamps. But now, with battens and footlights, each with two or three hundred jets all in one blaze, the figures seem part of a glittering tissue, and do not stand out. It does, therefore, seem that these splendid displays rather impair than increase illusion; in which connection may be considered the position of the spectators, in reference to the stage.

Formerly, every one was virtually in the house, the pit, as in the old Haymarket, in the centre, encircled by the boxes. Now, the exigencies of making the house hold as many as possible, have driven the pit into an excavation under the boxes, with the stalls interposed. The balcony projects out over their heads. To let the pit have some sort of view, the stalls are sunk down very low. These changes, however justifiable, have affected the sense of illusion in a very remarkable way. For instance, to the tenant of the stalls, there can be nothing illusive in what he sees. In real life, the head and face of a person is always much nearer to our eye than his feet. But from the stalls this is reversed, and the angle becomes a distortion, the head being farther away than the feet. The feet are actually nearer to us than the head. In such a distortion it is impossible for a spiritual or illusive feeling to arise—everything seems earthy. The same distortion arises from the arrangement of the boxes and balconies, which, in spite of ingenious bends and curves, never supply a suitable or comfortable angle of observation. Now, in the great architectural theatres, such as the noble one at Bordeaux, these matters are carefully looked into. The stalls are placed slightly below the stage, but ascend to the back, while the first tier of boxes is almost on a level with the stage. At the Alexandra Theatre, at Liverpool, the same arrangement is followed, with great nobility of effect. This is the true disposition of a theatre, and it necessarily excludes the burrowing under the boxes to find space for a pit. The actors' voices are lost in these cavernous recesses; they lose the inspiring sense of having the whole audience before them—the rows of intelligent and sympathetic faces.

Illusion, then, is the great point, and very small resources will compass illusion. Even

the familiar curtain can be made to contribute. It is becoming the fashion to have divided curtains that fall between the acts, made of a sort of tapestry or simulated. These close imperfectly, and nearly always indicate the super behind, who has to rush and hold them together. But does this suggest the idea of the great barrier that should always exist between the mystic scene and the hard practice of life. It imparts a sort of trivial drawing-room association. We feel that we might step up on the stage and peep in. But it is otherwise with the old traditional heavy green curtain, which floats downwards with slow and solemn folds. Both curtain and drop scene represent the barrier between the real and the ideal world. The floating green curtain on which the eyes of the audience rest during the interval before the performance have a special significance and a dramatic meaning.

Again, the drop scene, which marks merely a suspension of the dramatic interest, should not have the solemn finality of the green curtain. It is a subject of speculation what should be portrayed on its simple surface. Sometimes we have seen landscape, by Telbin or Beverley, enclosed in a border, or it may be a grouping of painted draperies and curtains. Garnier, the architect of the Paris Opera House, holds that this is the most fitting treatment, as it represents the function of the canvas, which is to be a curtain—and if these draperies are skilfully executed with pleasing colours the effect is good. An objection to the landscape is that it impairs illusion, as it is in fact only another scene; and when it rises some of the effect of surprise is lost, when the regular scene appears. This may seem a trivial point, but by being attended to it fosters illusion.

Space does not allow me to say more, but I think I have indicated, though in a sketch way, all the crucial points of this most interesting question.

DISCUSSION.

Mr. Lascelles Scott thought some of the criticisms in the paper on the scenic illusions of the present day would be taken to mean rather more than the author intended. For instance, he did not think it could be his intention to throw cold water on the magnificent display of the theatrical engineer, to which the attractions of London theatres owed so much; and he hardly thought the conclusion was justified that people took no notice in real life of doors or passages, and that no semblance of them was required in the theatre. By following out the laws of optics, effects were gradually being introduced on the stage which were a great advance on former practice; for example, the use of coloured glass on gelatine in place of the old coloured fires. He believed the late Madlle. Beatrice was the first to put forward the notion that people upon the stage, as in real life, should not always remain under the same optical conditions, and show the same colour and complexion as if nothing had happened to them, whether joy, sorrow, illness, or death. Those who had seen her would remember that, under the influence of a subtle poison, her complexion gradually changed colour, until it took the ghastly hue of death. This was accomplished partly by the marvellous art of the actress in holding her breath in a particular way, and partly by the impingement of a monochromatic light upon her face. One point he had hoped would be touched upon, though it perhaps did not come strictly under the title of the paper, viz., the arrangements or malarrangements made for the actors and supernumeraries behind the scenes. Both in London and the provinces a great deal of alteration was required, and he hoped the Society of Arts, which had done so much useful work in various ways, would not omit to insist upon the necessity for sanitation in this respect. He had recently examined a great many country theatres, and had been much pained at what he saw, and at the result of his inquiries. He would venture to say that in three cases out of four the accommodation provided for all but the principal actors and actresses, in country theatres, was decidedly harmful to health, and in other ways. In one of the manufacturing towns in Yorkshire there was a theatre where the companies which knew it always sent someone before with a large supply of disinfectants and perfumes; and he heard from a person, connected with a well-known company, that from this same cause it not unfrequently happened that several members were unable to appear.

Mr. Walter Emden said he had listened with interest to the paper, but he had hoped to hear more of the present system of working, and some suggestions for improvements in the future. At present nearly every stage, both in London and in the provinces, was worked on the same system as had been employed from time immemorial. Since scenes had first been used, grooves, borders, battens, and slides, had been employed, and they were used still; and unless some radical change were made they would continue. He had lately to report upon an entirely new system of working the stage, and though he would not say it was perfect, it certainly seemed to possess many advantages. It was in one of the Stadt theatres in Germany, three having been fitted up in this way, and one great object was to prevent the risk of fire. It was somewhat similar to something which had been described

in the paper. Having been conversant with stages from a child, he did not think there was any place so confused, so full of timber, and of every imaginable and unimaginable object, as the under side of a stage. This system consisted of a number of pistons, worked by hydraulic power under sections of the stage; on a lever at the side being touched, any particular section could be raised, depressed, inclined, or made to rock or move in any direction required. One great help which this system gave to the building of scenes was, that if a platform was required at any portion of the stage higher or lower than another, a terrace, or a gradual incline, it could be made at once by the stage itself, instead of having to be built upon the stage. When it was required to remove this and change the scene, the lever was moved, and down came the platform into its position again. All flats, wings, and such things were entirely done away with; the whole stage was a clean open space. Above in a gallery sat a man at a sort of piano; he put down certain stops, pulled a lever, and down came a curtain, which formed the wings, back, border, or whatever was required. They all came down from above, and were lowered down to the stage level. If it was necessary to fix any portion of the scenery on the stage, it was simply moved forward with a kink in it, and a strut put behind. The whole arrangement was simplicity itself, and in the course of twenty-four hours they made three heavy changes, two operas and a piece; and so silently was it done that the rehearsal of the succeeding piece or opera went on during the time the change was being made. Borders were done away with, and the sky was produced by a continuous curtain on three sets of rollers. It was so high that those sitting in the front row could not see the top,. When it was required to produce night or day, sun, storm, or fine weather, the rollers went round, and the suitable sky appeared. This curtain went all round, and all the scenery was in front of it. The risk of fire was enormously diminished by doing away with nearly all the battens, and from there being so much less timber about, either on the stage or under it. Fire would not catch very easily under a flat piece of timber; it was when it was upright, so that the flame caught the two edges and there was a draught, that it burned so quickly. Only half the number of men were required in the theatre, and though the system was not perfect, this seemed to him the direction in which improvement should be sought. Theory alone would not do in a case of this kind, but practice must go with it.

The CHAIRMAN inquired if Wagner's theatre at Beyreuth was one of these Mr. Emden had referred to.

MR. EMDEN said the one he had seen was at Hallé; there was also one at Pesth.

Mr. HYDE CLARKE did not agree that the question had been treated solely from a theoretical point of view; one of the most valuable parts of the paper was the account of practical failures and little technical deficiencies which had stood in the way of improvements. The subject was one of interest to every engineer, and illustrated the very wide range of scientific knowledge and its applications; it showed how the views of scientific lecturers had an ultimate bearing on the stage, which was not only a matter affecting the popular entertainment, but also the employment of very many men in this country. Remembering the way in which, in Paris, physical, chemical, and mechanical knowledge was brought to bear on these matters, it would be seen that it would not do for this country to neglect anything which, even in a small way, contributed to the national wealth. It appeared that M. Foucault, a distinguished philosopher, and man of great attainments, did not think it beneath him to employ his abilities in endeavouring to improve stage machinery, but, as it proved, his theoretical knowledge was insufficient to meet the problem without the practical skill which he lacked. They knew that that which was theoretical in the laboratory became practical in the factory, and how an experiment which produced no pecuniary results might ultimately become the means of building up a large branch of commerce. There was a well-known instance, of which evidence had been given before a Parliamentary Committee, in which a Birmingham manufacturer was almost offended at being asked if he could make dolls' eyes; but on finding the magnitude of the order which was offered him, he willingly accepted it, and thus founded a large industry which had given employment to large numbers of people ever since. They never knew what was trivial, and could not say that anything was unimportant. Looking back on the history of the stage and its literature, one of the most striking facts was the great constellation of genius which appeared in the time of Elizabeth, when not only Shakespeare appeared, but a number of great dramatists, each of whom would have given distinction to any other epoch. We could not have Shakespeares or Newtons born every year, and we know that there were periods of brilliancy and of obscurity. The present period was certainly not so brilliant as some former times, but there was hope that many now present might see a great revival in dramatic literature, and perhaps, too, the ingenuity of engineers might give them better appliances and effects than any hitherto seen. It was a curious fact, known to students of dramatic literature, that in France also the periods of brilliancy and dullness coincided with those in this great country. They were much indebted to Mr. Fitzgerald, and no doubt practical men would be able to benefit by what he had put before them.

The CHAIRMAN said it had occurred to him to ask the question, what would be the impressions of a spectator from a previous generation, suddenly

introduced to the glories and wonders of a modern theatre, with all its variety of lighting, all its scenic decoration, and mechanical contrivances. If he came from seeing Æschylus, or Euripides, or Sophocles, or Aristophanes, in the great theatres of Athens, he would of course, be mightily astonished at the lighting, because all the dramatic representations he had listened to were carried on under the open sky, and by the light of heaven; but he did not think he would have been so much surprised at some of the mechanical contrivances of the stage, because it was quite clear that, in the case of the plays of Aristophanes, to produce the effects necesssary there, a considerable amount of theatrical machinery must have been required. That, being of wood, had entirely disappeared, and nothing remained but the solid architecture of the theatre. If he came from Rome he might be surprised at almost everything, for the comedies that the Roman citizen saw—the plays of Plautus and Terence—all belonged to that school of drama which was reproduced in England by the popular comedy of the last century, and in France by the Molière style of play, in which the most important theatrical property that occurred to his recollection was the screen in the *School for Scandal.* So far as he remembered, every play of that class might be acted without any property or special scenery or appliance whatever. Then, coming to our own country, what would a spectator think who had seen Shakespeare acted at the Blackfriars or the Globe? They knew the sort of apology which was made in those days for the want of anything like scenic illusion. It was all alluded to in the choruses to *Henry V.* A modern manager brings his horses on the stage, either with two men or boys to make the forelegs and hindlegs, or more frequently now, the actual live quadrupeds themselves. In the chorus to the second act of *Henry V.* there was a description of how the playhouse itself is to be transferred to Southampton, and then how they are to cross the Channel to France, and the chorus assured the audience they would do so without any of the inconvenient effects which most people did feel in crossing the Channel. Then there was in the chorus to the third act an appeal to the audience.

> "Still be kind,
> And eke out our performance with your mind."

Now audiences were saved all trouble of that sort; they need not bring any mind at all to the theatre; they were not expected to do so; it was all done for them by carpenters and scene-shifters. Then at the very last there was the well known apology for the feeble attempt going to be made to imitate the battle of Agincourt, where the combatants are to be represented by "four or five most vile and ragged foils." When he saw Shakespere played he did not enjoy it any the more for having these wants supplied, for which the players at the Globe and the other theatres of the time made this humble apology for not being able to supply. On the contrary, he thought we had gone rather too far in the direction of realism. Apart from all the details of flies, flats, stage borders, and so forth, there lay the æsthetic question, what were the real limits of dramatic illusion? Of course, a manager who was catering for the taste of the public must consider what was expected, and, there again, taste had altered so much that you must expect the theatrical world to accommodate itself accordingly. People in the old days were not scandalised when they saw Garrick play "Macbeth" in a general's uniform of the period; it did not strike them as being odd or wrong, and, therefore, it was not. And he would, he thought, rather see Garrick play "Macbeth" in an English general's uniform than certain other people play it in the most correct representation of what they supposed Macbeth actually did wear, which he did not think anybody really knew, because the Highland costume which John Kemble introduced was probably just as unlike what Macbeth really wore as a general's uniform of George III's time. The manager must accompany public taste; he must not fall behind it. If possible he must try to educate it and keep it within proper bounds, but he should not try to go before it, encourage indulgence in mere scenic display, which did not add at all to the poetry or interest of the piece. A little anecdote he met with recently, in Marmontel's memoirs, showed that realism might be carried a little too far, and distract attention from the real business of the scene. It was a little later than the middle of the last century, when a great actress, whose name he did not remember, was playing Cleopatra at the Theatre Francaise, and had to apply the fatal asp which was to bite her arm. At that time there was living in Paris the well-known mechanician, Vaucanson, who made so many most ingenious automaton figures, and he exercised his art in the production of a most beautiful little automaton, which, when placed on the lady's arm, began to crawl, and lifted its head in the most natural way, and finally made a dart to inflict the bite. It was very beautiful; but it was found after a night or two that the audience were so much occupied in watching the movements of the little asp that the lady felt she was neglected, and it was, very sensibly, discontinued. This showed how realism might be carried too far, and it was carried too far if it at all interfered with the real business of the scene. He remembered the old state of things in London theatres, when there was nothing but a place at the back, opening and closing, varied by the raising and lowering of drop scenes, the old side scenes moving in grooves, and the old flies across; when the same scene of the hall used to serve for the interior of the castle at Elsinore, the hall of Macbeth's palace, for King John's palace, or Henry VIII's or any other palace that was wanted, and no one objected—"Oh! we saw that scene in another play." Their minds were used to making the necessary supposition that it represented for the time what was wanted. The same with the dresses. People did not expect, when a play came out, that all

the dresses should be new, and did not object that they had seen a man play Horatio in the same dress in which he played Gloucester on another night. They were quite satisfied, and he thought managers ought to have been better satisfied than they were now, for it cost them a great deal less. Five or six years ago, he was very agreeably reminded of that old state of things by visiting the theatre at Mannheim, which seemed not to have been touched for fifty or sixty years, and he was very glad to see the old flats and side scenes which reminded him of his early days when he first found enjoyment in seeing plays acted, which had been ever since one of his great delights. He concluded by moving a vote of thanks to Mr. Fitzgerald.

The vote of thanks was carried unanimously, and the meeting adjourned.

EXTRA MEETING.

Monday, March 14, 1887; Sir FREDERICK BRAMWELL, D.C.L., F.R.S, Vice-President of the Society, in the chair.

The Adjourned Discussion on Mr. MARSHALL'S paper on "Railway Brakes," was resumed.

Mr. HAROLD BROWN said he had been professionally connected with the vacuum brake from the commencement, and, in fact, was practically the founder of the company, having been led to look into the subject in the first instance professionally as a lawyer; he had subsequently gone more deeply into it, and had had the opportunity of conferring with a great many engineers upon it. At the present day the subject might be said to have an historical interest, and having read nearly every patent which involved any question of principle, from 1840 to the present time, he might say that the vacuum brake dated back to 1844, the first being that of Messrs. Nasmyth and May. Compressed-air brakes took their origin four years later, the first patentee on that side being also an Englishman of the name of Lister. The question had passed through phases too intricate to follow, but there were chain brakes, bars, and ropes, all acting by tension, brakes acting by torsion through bars, buffer brakes, skids, wedges, brakes applying friction on the wheels, on the rails themselves, on a special centre rail, brakes actuated by weights, by compressed air, by compressed water, by every compound of water one could imagine, and by almost every other fluid; then there were steam brakes and vacuum brakes; and, lastly, there was every combination of all these which could possibly be conceived. Ultimately, they had come down to very simple forms. One gentleman had actually gone to the expense of taking out a patent for a brake which was to be operated by throwing out an anchor behind the train attached by a rope to the train, which would wind up a spiral spring. How he got the anchor back again when the train stopped he did not know. There could be no doubt that the public were, in early days, very much indebted to Messrs. Fay and Newall for the first practical continuous brake acting by tension. Clarke and Webb afterwards employed tension, and these two were the best which, up to 1875, were approximately continuous. Mr. Marshall had said that they were indebted to Americans for the only two practicable forms of brakes now in use, but, for the honour of England, he must take exception to that. Mr. Westinghouse was well known to be an American, but there was a compressed-air brake which had not attracted so much attention, the Steel and McInnes, which was unquestionably English, and the vacuum brake was not American at all; Mr. Smith, whom he knew very well indeed, always strongly repudiated being an American, being, in fact, a native of Cumberland. The vacuum brake had passed through a succession of English inventors; next to Mr. Smith, in point of date, came Saunders, and, in fact, Saunders and Bolitho were practically contemporaneous. Then there were Hardy, Aspinall, Clayton, and last, but not least, Mr. Gresham. For the brake rigging, which was exceedingly complete and simple, they were indebted to Mr. Clayton, of the Midland Railway; and the present vacuum brake was from end to end entirely English. The history of continuous brakes might be summed up as follows. Up to 1870 there was no very great interest taken in the question; in that year Mr. Westinghouse commenced patenting compressed-air brakes, his first patent being dated in that year. That was a simple brake. His first automatic patent was in 1871, but that was not the one now in use, which had been much elaborated since. The first patent vacuum brake now in use was Smith's, which dated from 1873. Mr. Westinghouse's simple brake was first adopted on the Metropolitan District Railway in 1873, and the vacuum brake on the Metropolitan and St. John's-wood in 1874. In 1873, the Westinghouse automatic was adopted on the Midland and one or two other lines, and since then he had elaborated a most extraordinary series of inventions, embodied in 37 patents and no less than 159 claims, but he could not say how many of these were embodied in the apparatus now used, as shown on the diagrams. The next step in the controversy was the brake trials at Newark. At that time there was no automatic vacuum brake, the only one of that character submitted for test being the Westinghouse, except an automatic vacuum brake, also patented by Mr. Westinghouse, but which practically did nothing, and had not been heard of since. In 1877, the report of the Royal Commission came out, and though they had the question of automaticity before them, they studiously abstained from recommending it. In May, 1877, Sir Henry Tyler read a paper in that room, in which the question of automatic or non-automatic brakes was discussed,

and on August 30 in the same year certain regulations were promulgated by the Board of Trade which practically embodied certain recommendations which had been laid down by Sir Henry Tyler in that paper. In 1878, the first automatic brake which had come into practical use was patented by Mr. Aspinall, who modified the original Hardy cylinder by closing the bottom, and applying a sleeve to it and a valve. From that time the automatic vacuum brake had gone through a series of improvements, chiefly, in his judgment, in the direction of increasing simplicity of construction and operation, until, at last, it arrived at the simple form in which it was now presented. It was a curious thing that though the Westinghouse had been before the railway world since 1873, and the Vacuum brake did not come before them until 1879, or thereabouts, the comparative progress of the latter had been the more rapid of the two. He had taken out the figures from the Board of Trade Returns, and he found that in 1880 there were only 323 engines and 1,707 vehicles fitted with the automatic vacuum brake, whereas in 1885 (he had not the returns for 1886, but he knew they would be considerably larger), the number of engines was 1,990, and the vehicles 10,834, showing an increase of more than six times in that period. With regard to the Westinghouse, the figures were these: —In 1880, engines, 491; vehicles, 3,386. In 1885, engines, 1,599; and vehicles, 13,837, or an increase of only four times. During that period two very remarkable events occurred with regard to the Westinghouse brake. The Midland Company, which had been almost the first to adopt it, and had tried every species of brake which could be recommended, and certainly everything which Mr. Westinghouse recommended, after a series of exhaustive experiments, determined to abandon the Westinghouse, and adopt the automatic vacuum brake, and the Lancashire and Yorkshire did the same. He believed the action of the Lancashire and Yorkshire in this respect was owing, to a great extent, to the opinion of an eminent officer of the Board of Trade, now no more, whose opinion was expressed after the Blackburn accident. He said, in his report, "The Westinghouse automatic air-pressure brake is a very clever and ingenious piece of mechanism, made up of a great number of separate parts together having automatic action, but, as is well known, the greater the number of parts in any piece of mechanism the greater the liability of failure, and I consider the liability to apply itself when not required, and when there is no accident, and to fail to act or go on when absolutely required by the engine driver, constitute two grave defects in its present construction." With regard to the merits of these rival brakes it was, of course, very difficult to discuss such a question without being accused by one side or the other of partiality, but the only way to arrive at a result was by discussing them freely. Mr. Gutch said Mr. Marshall was not impartial, but he thought he should be able to show that, in some respects, he had erred by treating too lightly some grave defects of the Westinghouse brake. If the vacuum brake advocates had complained of Sir Henry Tyler's paper in 1877 in any way invidiously, he would have felt that they were doing him an injustice; he certainly endeavoured to deal them a grievous blow at that time, and made a terrific onslaught on the vacuum brake as it then existed, but they bore it patiently and wisely, and he ventured to hope that if Sir Henry Tyler had had that brake as it now existed before him, he would have spoken very differently of it. The merits of the brakes appeared to depend on one or two main points. As to the power, he thought that was beyond discussion, but he had brought with him certain figures issued by the Midland Railway, giving the results of the exhaustive experiments which, after years of experience, they made in 1882, and which he would hand in, only mentioning two stops. At a speed of 52 miles an hour the automatic vacuum brake stopped a train in 287 yards, and in 20 seconds; at 50 miles an hour in 253 yards, and in 18 seconds; and he was quite prepared to admit that on this point the brakes were practically equal. Then came the all-important question of simplicity. He would not discuss the various parts, as they had been so well described, and could be seen on the diagrams, but on one point he would point out what appeared to be an error. At page 428, Mr. Marshall said:—"In the vacuum brake, besides the driver's valve, which is not very different in character in the two brakes." He must dissent *in toto* from that proposition, for, so far as he could see with regard to the driver's valve, when once you left the handle there was nothing in common between the two. They equally open the passage for the admission or emission of air, but there was nothing in the vacuum brake in the driver's valve compared to what was shown on the diagram of the Westinghouse brake. There were none of those complicated internal parts and springs and moving portions which were so apt to become deranged. Then coming to the triple valve, Mr. Marshall said when in good order it would do so and so. Mr. Westinghouse and his supporters had recognised themselves that it must be in good order, and one of Mr. Westinghouse's most consistent supporters, a most able railway engineer, Mr. Harrison, of the North-Eastern, had from time to time circulated methods for instructing railway drivers in the use of this brake, and there was an elaborate itinerant school van sent about to instruct drivers how to manage it. That alone was sufficient to show the complicated and intricate character of the apparatus. In contrast to that, he would appeal to the well-known fact that, on the Southport Railway, nine trains were turned out on one day with the automatic vacuum brake, with practically only a few hours' instruction to the engine drivers, and they all worked without the slightest hitch, and had done so up to the present day. There was also

the question of cleaning these complicated and intricate valves, and on this point again Mr. Harrison had circulated statistics as to the time occupied in cleaning various parts of the Westinghouse brake. For the triple valve alone he allowed seven minutes for cleaning. He was not a practical man, and did not think he could clean one at all, but it did seem to him a very moderate estimate, but even at that, take 1,599 engines and 13,837 vehicles, it worked out that to keep those valves clean for a single year, the triple valve alone would require 1,820 hours, or 182 days of 10 hours each. With regard to the action of the valve, they had an interesting description of what he should call the intended action of that valve. It required a balance pressure so carefully adjusted that you had to insure the motion of half an inch, and half an inch only, in the little slide valve. He should call it almost a conjuring trick. He had made some attempts himself at the Exhibition, and could not work it, though he must admit that the scientific operators showing the brake certainly did produce certain motions in that valve. He did not think that was a recommendation, as it required very intelligent operation of the driver's handle, with a very light hand, in order to produce that result. Another important point was durability. The materials of these brakes were substantially the same, and, therefore, the question of durability amounted to this, whether the same material would stand equally well an internal bursting pressure of 70 lbs. to the inch, and an external atmospheric pressure of practically 10 lbs. to the inch. Such a proposition only required to be stated to refute itself. Here, again, he must take exception to Mr. Marshall's paper. At page 429 he alluded to this question very tenderly, and did not attach to it the weight he should be disposed to attach to it, in considering the practical value of the two brakes. The best way was to appeal to the figures published by the Board of Trade annually. He had taken out the figures for five years ending June, 1886. He found the Westinghouse brake ran 155,000,000 miles and made 1,500 failures, the vacuum brake 224,000,000 miles and made 1,800 failures; the average working-out for the Westinghouse, one failure to each 28,500 miles, whereas the other only made one failure in 124,500 miles. He knew that exception had been taken to the reliability of the Board of Trade returns in this respect, that they did not show the real comparative number of failures, because it was said so many were due to failure in materials, or to negligence of railway servants. In order to test that, he had, for himself, taken several half-yearly returns at random, and eliminated from them everything which, upon an impartial consideration, he thought could fairly be attributed to causes other than what were alleged by either side to be the inherent defects of the opposite system. For instance, he rejected broken brake gear, broken pipes, couplings left unfastened by negligence of servants, and matters of that sort. Wherever he could see they were not fairly attributable to the system, he rejected them, but he had retained faults like burst hose or triple valve sticking on the part of the Westinghouse, and on the part of the vacuum brakes such things as obstructions in the pipe, and, although he did not think he ought to have done so, places where they ran through stations, because he knew that Mr. Westinghouse alleged that with the simple brake that was a defect in the simple system. But, even giving him that advantage, the result to which he came was that the figures were substantially exactly the same as by taking the gross returns of failures as given by the Board of Trade. Now, this question of failures, he must say he thought was a test of the whole system, because every failure in a continuous brake was a possible accident. That was incontrovertible, and, if necessary, he might refer to the accident which occurred in the Blea-moor tunnel. No doubt he would be told that there were other causes leading to that accident; but the primary cause was that a hose blew off, and hoses would blow off, so long as you tried to put 70 lbs. to the inch pressure inside them. With regard to the preservation of power, Mr. Gutch objected that you could not get the brake off quickly. On this he would give some figures. Mr. Gutch said the vacuum had 40 times as much air to exhaust, but he thought that must have been an unintended remark; at the utmost he must have meant four times. He had got the exact figures of the quantity of air to be removed from the engine and tender, and nine vehicles, making 400 feet of pipe with connections, carefully taken out. With the vacuum in a pipe of the standard size, there were 61,812 cubic inches; in the pressure brake you had to force into the same length 190,392 cubic inches of air. In the one case he took 20 inches vacuum, and in the other 70 lbs. pressure. Then there was the question raised as to the speed of taking off the brake. He found that, making a full application of the vacuum brake, you had to exhaust from the pipe, after the brake was put on, 19,663 cubic inches; on the other hand, Mr. Westinghouse had to force back into his brakes and the parts of his apparatus, 20,021 inches. In these cases, the figures being practically equal, that was assuming that, in the latter case, the pressure was regulated by the valve so nicely and correctly that the driver only allowed to escape from the parts of his brake 30 per cent. of the compressed air which he had in them. If he allowed more to escape, of course there would be more to force in. He had exact tables of the time occupied to get the pressure, taken by the Midland Railway Company for the information of other companies, in September, 1884. The time occupied to get 20 inches with the vacuum brake, throughout the whole train, with the large ejector, was 59 seconds; with the small ejector, 1 minute 47 seconds; with both together, 50 seconds. To get the 70 lbs. pressure per inch in the Westinghouse, in the first instance it required 6 minutes 40

seconds. In order to release the brake, after application with the automatic vacuum, it took practically 1 second per vehicle, or 12 seconds, and to completely restore the 20 inches vacuum throughout the train, 30 to 34 seconds with the large ejector, and $1\frac{3}{4}$ minutes with the small. In order to re-produce the brake power in the Westinghouse, after the full application of the brake, it took $3\frac{1}{2}$ minutes. Mr. Marshall, at page 428, said that "in the case of several stops occurring in rapid succession, there is involved the risk of the exhausting of the reservoir being greater than the process of re-charging can keep pace with." That was not a risk; it was an absolute certainty. You could not go on applying the Westinghouse time after time without exhausting the reservoir, unless it were of such abnormal size that it was practically impossible to work it in ordinary traffic. The graduation of pressure was even more important, probably, than this. On inclines it was of the utmost importance to prevent skidding, that the driver should be able to reduce the pressure on his brakes gradually at various points of the incline, or he would skid the wheels. Now, he ventured to say that, although you could increase the pressure in the Westinghouse brake, you could not reduce it—you must take it off and put it on again; and, consequently, there was an intermittent action and irregular action, for working down inclines. Mr. Gutch asked why Mr. Marshall did not go to the Exhibition or to the company's works to see the action of the valve. He ventured to say that exhibitions of that description were not the best places in which to see brakes. He saw the brake at the Exhibition, and he had grave doubt whether any engine or train could ever be fitted with such a big reservoir as they had there. Again, the valves were constantly cleaned; they had any amount of careful attention, and, of course, beautiful adjustment. There was no vibration, no grit or dust from the ballast, and, consequently, these delicate parts of the triple valve might work there perfectly; but it did not follow that they would operate so well in actual working. He thought Mr. Marshall, as a practical engineer, very wisely preferred to see this brake in actual work, and considered that the single fact with reference to the train on the Rocky Mountains, where the automatic action was disconnected in order to let the train run down the line, was conclusive. Mr. Gutch complained that there were not long inclines worked with the vacuum brake. They had trains fitted working 18 miles on the St. Gothard incline perfectly satisfactorily. They could not make their inclines longer for any better test. They had also trains on the Bhore Ghaut inclines of the Great Indian Peninsula Railway, and other important lines in India. With regard to the leak-hole, he would leave that for Mr. Clayton to deal with. It was not the property of the company, and had always been disowned. At the same time, he thought he could find a leak-hole in some of Mr. Westinghouse's patents, if necessary. The question had been much mooted in the House of Lords with regard to Government interference, and he hoped they would never see Government interference on this or any question of the detail of railway construction, which, it seemed to him, would be fatal to progress. The whole responsibility for working railways should rest on the responsible officers of the companies. It would be monstrous that they should have a Government prescribing what brakes should be used, what wheels, what iron, and what kind of rails. How could the wholesome control which was exercised over railway companies by means of the British jury, be continued if the Government were once to undertake prescribing to railway companies where they were to get their materials, what they should be, or what apparatus they should use. Practically, the only question which remained to be decided was as to the universality of railway brakes, what brake was to come into universal use? At the same time, it would be greatly to the interest of the public that the brake which, now on its merits, the Grand Trunk lines had adopted, with the universal coupling, should be made the brake of the United Kingdom, otherwise there would never be an interchangeable or a universal brake. That brake, he was happy to say, was the vacuum brake. It was used by the London and North Western, the Midland, the Great Northern, the Great Western, London and South Western, and the Lancashire and Yorkshire, and if you looked at a map of those lines, it would be seen that it would become exceedingly bad, as long as the advisers of those lines kept to their decision, for any other brake to become anything like a universal brake in England. It was to the interest of the public that the vacuum automatic brake should be adopted throughout England, and if any legislative steps were taken it must be in favour of that system, otherwise it would be going contrary to the whole weight of working professional opinion, which was the only real test to which these things could be applied.

Captain FAIRHOLME said he would not attempt to dispute the fact that the compressed air and vacuum brakes had so completely taken possession of the chief English railways that it was almost useless to attempt to replace them; at the same time, as representing a mechanical brake, he must make a few observations, because the Heberlein brake had acquired on the Continent, and in other countries, a considerable extension, which was daily increasing. Mr. Marshall had given a very fair description of the brake on the whole, though not quite correct in some points. It was not actuated in every vehicle by a cord, but by a lifting rod and handle, which thus made it also a hand-brake, and that was one of its great advantages, because all air brakes were quite useless unless the engine were there; and a certain number of vehicles had, therefore, to be fitted with the old hand-screw brake. The Heberlein brake, as now made, was the simplest and most practical hand-brake possible, and, at the same time, was continuous and automatic. The guard in the

van could command the whole of the brakes in the train if necessary, whereas in the Clark-Webb system neither the guard nor the engine driver ever had had control of the whole of the brakes. In this case, the driver had the whole control independent of the guard, and yet, at the same time, the guard, by elongating or shortening a pulley formed by the cord, could control the brakes equally with the driver. It was also a mistake to say that in the Heberlein, as in all chain brakes, there was an unpleasant harshness of action. The present Heberlein was not a chain brake at all, as the term was generally understood in this country. A chain brake was an arrangement whereby, by means of a long continuous chain, a certain number of carriages were braked by one apparatus. That was originally the form of the Heberlein, which had then the same fault as the Clark-Webb, namely, that the cord had to be pulled to apply the brake; the moment the alteration was made, and the cord was pulled to take off the brake, the most perfect automatic action was attained; and then the inconvenient continuous chain arrangement under the carriages was done away with, and each vehicle had its own Heberlein brake, which made it a combined hand and continuous brake. Again, it was said the brake went on too suddenly; but he was sure Mr. Marshall would not have said so if he had ever travelled in a train in which it was used. The speaker had often stood with his watch in his hand to time the operation, but had frequently been unable to determine when they began to act. When the Westinghouse brake first came out, before the drivers were used to it, the train was shaken about fearfully; it was the same with any powerful brake; if stupidly used, it must give awkward jerks, especially with loosely-coupled carriages; but there was no difficulty of the kind now with the Heberlein. One of the most eminent railway engineers of this country had stated that he had tried it under every possible condition, and found the arrangement very simple, not likely to get out of order; and he was much struck with the facility with which it could be manipulated, and the ease and rapidity with which the power could be applied according to the requirements. It was now in operation on a line the gradients of which were greater than those in the Rocky Mountains, namely, on the La Guaira and Caracas line, in Venezuela, where there was a length of twenty-two miles, with a grade of 1 in 27, and with a succession of curves and double curves of 130 ft. radius; it had been running there three years without a single difficulty. A few weeks ago the railway was asked for information as to its working, with a detailed series of questions, all of which were answered most satisfactorily. The automatic action never caused such inconveniences as those resulting from burst air pipes, as the cord always broke when required, but never otherwise. Mr. Harold Brown had referred to the Clark as being the first brake of this class; but Mr. Heberlein's first patent was taken out some years before Mr. Clark's was heard of, the latter being dated in 1862. When he (Captain Fairholme) came to England, in 1872, he submitted this brake to Mr. Burnett, of the Metropolitan Railway, whose reply was that it was a clever invention, but had been forestalled by Mr. Clark. By accident, however, he turned up, at the Patent-office, a patent (a communication from Mr. Heberlein) of 1856, and on showing it to Mr. Webb, he at once remarked that Mr. Clark's patent was anticipated. Mr. Heberlein really was one of the oldest brake inventors in Europe, and devotedhis whole life to it. The Prussian Government had adopted this brake for 3,000 miles of local railways, and was adding it every year on all lines of that description.

Mr. Clement E. Stretton said the Amalgamated Society of Railway Servants, on whose behalf he attended the meeting, viewed this question from an independent and somewhat different point of view from that taken by previous speakers. They estimated the value of all such appliances in proportion as they provided for the safety of their own members. At the same time, whatever the society was able to do for the protection of its members in charge of trains must also be for the advantage of railway passengers. As had been said, it was very difficult to express any opinion on this important question without being considered a partisan of one or other of the various systems. He was glad to find that Mr. Marshall was of opinion that there were practically only two brakes in question, the automatic compressed air and the automatic vacuum. For many years the battle had been between automatic and non-automatic, but there could be no doubt now that some kind of automatic brake must be adopted. Mr. Marshall came to the conclusion that there was practically no difference between the two brakes as regarded the time taken in the application; but on this point he should be glad of some further information. An express train, running at the rate of sixty miles an hour, passed over a distance of 88 feet in a second, so that half a second in time must make all the difference between life and death to those in the train. During the past 18 or 19 years he had attended nearly all the brake trials in this and some other countries, and although he had no wish to favour any one brake in particular, still, as a matter of fact, he had never been able to find any brake which was capable of quicker application than the Westinghouse. The London and Brighton Company, in October last, very courteously allowed the Railway Servants' Society to examine and test a train, and they then found the Westinghouse as nearly instantaneous in action as could be imagined. With regard to the question of regulation, he might say that he had, through the courtesy of railway companies, ridden for numbers of miles on engines and in trains fitted with the Westinghouse brake, and he found that the triple valve did regulate the brakes, and that they could be controlled in the

manner intended. Trials were made at Newark, on the North British and North Eastern, and there were also the exhaustive experiments by Captain Galton, and also on the London and North-Western, all of which he attended, and he believed the reports of those trials would bear out his statement that the brake was regulated on all those occasions. With regard to the defects of various brakes, there was no doubt a defect in the Westinghouse, that the hose-pipe was liable to burst and stop the train. He had been in a train when this had occurred. In the vacuum, on the other hand, on some occasions the rolling ring of the piston became twisted, and on some occasions he had known the piston rods stick in the packing. On a recent occasion he remembered a delay of some minutes from this cause. There was also no question that great inconvenience was caused by the brakes being applied when shunting or changing engines. There was no diagram shown of brakes upon engines. Steam brakes were used on several engines and tenders, controlled by means of a valve intended to make them automatic, and so long as the engine and tender remained coupled together they were so; but from information supplied to his Society, he understood that if the engine and tender parted, as happened in the Penistone accident, the steam automatic brake was rendered useless in consequence of the breaking of the pipe between engine and tender. He brought forward these points at his Society's request, in the hope that they would be remedied, and he trusted that this paper and the discussion would tend to assist in bringing the best brake to the front, and that that which was proved to be the best would soon be adopted.

Sir Henry Tyler, C.B., M.P., said, as the Chairman had called upon him, he would observe that, since a period of 34 years ago, all these brakes which had been referred to had come under his notice one after the other, and it had been his duty to criticise them, and, as a Government officer, to discuss with the inventors the subject of them, and therefore he remembered pretty well the order in which they were introduced, which was not that given in the paper. The first continuous brake in this country was that of Mr. Newall. Mr. Marshall put it after the chain brake, but, in reality, it was before it. He called it the Fay and Newall brake, but there were two different brakes. Mr. Newall's was a brake connected with an iron cylinder at the end of the carriage with a spring in it. The brake was worked by hand over several carriages to turn it on, and the springs took it off. Mr. Newall was carriage superintendent to the East Lancashire Railway Company. Then came Mr. Fay, who, being carriage superintendent of the Lancashire and Yorkshire, constructed a rival continuous brake, which was worked without the spring, and was simply turned on and off by hand. When Mr. Newall first brought the brake to his attention, he said it ought to be made automatic; it should fly on by the action of the spring, and be wound off by hand. To every inventor of brakes since that time he had always made the same observation, that the brakes should fly on and not fly off; that the power, whether of compressed air or any other, should be utilised for putting the brake on rapidly in in case of any accident; and he was very happy to see that they had now arrived at the point, admitted in the paper, that automaticity was the proper principle applicable to all systems of brakes. Then came Mr. Clarke with his chain brake, and he told him the same thing, and in consequence, Mr. Clarke took immense pains in endeavouring to alter it from non-automatic to automatic, though he made it more complicated, as he found, in so doing. It was then taken up by Mr. Webb, and became the Webb-Clarke brake. As regards the Heberlein brake, it had never made much progress in this country, though it had been used extensively in other countries. He need not refer to the electric brakes, the buffer brakes, McConnell's steam brake, or others. Mr. Marshall, in referring to the compressed-air non-automatic brake, seemed to think that it had come after the automatic compressed-air brake, and he said the necessity for this had arisen from the circumstances of the steep lines that had to be worked in a certain mountainous district of America. So far from that being the case, when Mr. Westinghouse first came to this country, he brought a non-automatic brake which was already in use in America. He told him the same as other inventors, that it ought to be made automatic, and Mr. Westinghouse took a great deal of pains, and turned it into an automatic brake, and in almost all parts of America it was now so worked. There was now only one instance on a short line of the non-automatic Westinghouse brake working in this country. As regards the Rocky Mountains, he took Mr. Marshall's word that it was, on those inclines, turned into a non-automatic brake on the descent as he had described, but, if so, he ventured to say that it was quite unnecessary to adopt such an expedient; and with regard to the statement that the automatic form was not so well fitted for running down long steep inclines, he must differ from him *in toto*. There was no brake so well adapted for a long steep incline, whether going up or down, as the Westinghouse automatic brake. This was not mere theory, as a good deal of the paper appeared to be, but the experience of actual practice. He could instance many long inclines in America where the automatic brake worked every day with the most perfect success, and with the result which Mr. Marshall had so well described, when he said the trains seemed to float smoothly and easily down the inclines of the Rockies. What he saw done with a non-automatic brake on the Rocky Mountains, was done every day and every hour on the Alleghanies in working the Pennsylvanian Railway with the automatic brake, and his glowing description would apply equally well to it. Mr. Brown had made a

long speech of as impartial character as could be expected from the legal adviser of the Vacuum Brake Company, belauding the Vacuum brake, and attacking the Westinghouse brake; and as he did not wish to weary the meeting with long arrays of figures and counter-arguments, he would, with the permission of the Chairman, send a few facts and figures, to place by the side of those which Mr. Brown had given, which would show, what was already well-known, that there was nothing more easily distorted than facts except figures. It had always been alleged against the Westinghouse brake that the triple valve was a complicated device. Now, in 1874, he read a paper in that room on simplicity in railway working, and he ventured to contrast simplicity or complication in construction with simplicity or complication in working. At that time he was, on the part of the Board of Trade, endeavouring to induce railway companies to adopt certain devices, such as interlocking, the block system, and so on, and was continually told by the chairman and directors that all these things were very complicated, and would introduce a great many difficulties, and be the cause of many accidents. All these things had since been universally introduced; and those who cried out most loudly against them then would not now think for a moment of attempting to work without them. If that signal box at Cannon-street, full of complications as it looked, were taken away, the trains could not be run for a quarter of an hour in and out of the station. With great complication of construction you really had, then, comparative simplicity of working. The triple valve, of which a model was placed on the wall, though it looked complicated, was the most simple device in working he had ever come across. Mr. Westinghouse was one of the cleverest mechanics he had ever met with, and this valve was a masterpiece of ingenuity, its simplicity of working was absolute. He could refer to other instances of the same character; for example, he could point to hydraulic engines which—so to speak—worked themselves. To set them going you did not go to the hydraulic engines, but to one of half-a-dozen machines connected with them, and directly any one of these machines was set in operation, the hydraulic engines started themselves, because the moment the accumulator began to come down, the engines were automatically started to raise it again. Here there was considerable complication of construction to arrive at a beautifully simple result. So it was with the triple valve, which had cost a great deal of trouble and ingenuity to construct, but when once made and put in position, it absolutely worked itself. Thirty triple valves, on thirty vehicles, in a long train, performed their functions perfectly, by merely operating the driver's valve on the engine. If one went into the statistics showing the numbers of triple valves at work, and the work they had to do, and the length of time they had been working, it was as absolutely perfect a mechanical contrivance as was ever brought forward. Mr. Marshall had omitted to mention some points not very creditable to the vacuum brake. Mr. Brown had referred to vacuum brakes as if they all belonged to the same category, and were all of the same construction. There were a great number of vacuum brakes; there was the break of the Great Northern, which was non-automatic, and there were several automatic forms worked in different ways, but these all wanted something analogous to the triple valve, to make them more effective. For the want of it, there was not a single automatic vacuum brake at present which could satisfactorily work a long train on a long, steep incline. The device of leak holes had not been referred to by the author, or by Mr. Brown, though it was in use on the Midland and the Great Western Railways. It was reported upon by the Chairman, in 1881, to the directors of the Midland Railway, in contrasting the Sanders-Bolitho with the Clayton brake, when Sir Frederick Bramwell reported that the effect of this leak hole was that, when the power had been applied, it leaked off in two minutes, and he considered that two minutes was quite suffiicient in passenger trains, because if the train was on an incline, or there were any difficulties, those two minutes would allow the guards to apply their hand brakes, or to put scotches into the wheels, so as to prevent accidents. If, however, a train were running down a steep incline, and two minutes elapsed, and the power had leaked away, he could not see how it was possible for the drivers, guards, or anybody to go along the train while it was running down an incline, and put scotches into the wheels, and it did seem extraordinary that a brake could be considered perfect when it was necessary to carry a cargo of scotches, or rather sprags, in the brake van to prevent a train running away, especially as disc wheels were now commonly used, and sprags could not be inserted, as of old, between the spokes. He should like to hear presently what the Chairman's views now were on the subject.

The CHAIRMAN said Sir Henry Tyler had misquoted the report, so that he could not answer him.

Sir HENRY TYLER said he should be happy to read an extract from the Chairman's report, which was as follows:—"With respect, however, to the continued holding power of the brakes of a severed train, it appears that, owing to a variation in construction, which will be explained in the appendix, the Clayton brake will cease to continue its hold after the period for which, in its manufacture, it has been adjusted, viz., in the case of the train offered for our investigation, two minutes, while the Sanders' brake will continue to hold for a very long time, that is, until, by reason of the slight inevitable leakages, it falls off. In our opinion, however, the two minutes during which the Clayton brakes hold on, afford ample opportunity for the

application of the guards' hand brakes, or, should the train be on so steep an incline that the guard's brakes would not suffice to hold it, the two minutes are sufficient to admit of the application of 'scotches' to the wheels."

The CHAIRMAN said this did not mean, as the meeting would have gathered from Sir Henry's Tyler's previous observation, that it was assumed that working a train down an incline would involve it being done by scotches, but that, where a train parted, the part that came away would, after two minutes, require the application of hand brakes, which would be sure to be in the rear van, and if that were not sufficient, an equally ready application of the scotch, which was always carried, according to his experience, in the guards' vans. It had nothing whatever to do with the working of trains down inclines.

Sir HENRY TYLER said he had not heard of spraggs or scotches being carried in passenger trains for a very long time, but he was quite ready to admit that, if the Clayton brake were used, it was very necessary, on account of its tendency to lose its power in two minutes, to carry them. If Mr. Marshall would only go out amongst engine drivers who were using the Westinghouse brake, and amongst those using the various forms of the vacuum brake, he would get from them very strong and very valuable opinions, which he should be glad to hear him quote at a future meeting in that room.

The CHAIRMAN said he would next call on Mr. Kapteyn; but as the Westinghouse Company had been already very ably represented, he would invite him to confine his remarks to a description of the working of the triple valve.

Mr. KAPTEYN said when he heard the description of the triple valve given in the paper he was very much astonished, because a short time ago he had a letter from Mr. Marshall asking for information regarding the Westinghouse brake generally, and particularly as to the working of this valve. Although the author had not stated for what object the information was required, he was only too glad, of course, to give him the most complete information with regard to it. He (Mr. Kapteyn) wrote him several letters on the subject, and supplemented his explanation by sending him some reference books, plates, diagrams, and pamphlets, which he acknowledged, and as he did not take exception to his explanations, he took it for granted they were satisfactory. He was, therefore, much astonished to find, on hearing the paper, that, in the first place, the author had not understood the explanation he had given, and, secondly, he challenged the accuracy of the information he gave. He knew that, years ago, the triple valve was made by their opponents the bugbear of the Westinghouse system, but he had not heard much about it lately, and hoped that that erroneous conception had been got rid of, but it still, however, appeared to survive, and he was rather surprised to find that it had found its way into a paper read before the Society of Arts. The description given by Mr. Marshall was not exactly wrong, although it contained some inaccuracies, but it was put in such a way as not to be understood. (Mr. Kapteyn, by the aid of a working model, explained the action of the valve.) This being the proper description of it, he was astonished to find it stated in the paper that this supposed action is necessarily imaginary, and he would now proceed to disprove that extraordinary statement. In the first place, he would ask any one if they really believed that, if the Westinghouse valve could not be graduated, it would have been introduced to the extent that it had, an extent much larger than any other brake system on the surface of the earth. Any locomotive superintendent, as well as the public, would condemn a brake which could not be graduated, and any one who travelled in trains fitted with this brake would know, from daily experience, that sometimes the brake was applied gently, sometimes a little harder, and sometimes so sharply as to bring the train up to a sudden stop. This would be simply impossible if the brake could not be graduated. There were about 140,000 of these triple valves in use, and taking an average of about eighty times a day, that would represent about one million movements every day all the year round, which tend to disprove the author's statement. This was only indirect evidence, but he could go further. It was said there were no means of seeing into the chamber of the triple valve to observe what the actual motion was, but that was not quite correct, because he had had a demonstrative apparatus made, and shown at the Inventions Exhibition of 1885, which thousands of persons had seen, and which the author might have seen if he went there. It was the ordinary Westinghouse triple valve attached to the brake cylinder and reservoir, identical with any other valve as used. The whole apparatus was connected to the main pipe, and worked by a driver's valve in the ordinary way; but the piston stem of this working triple valve was connected by a thin rod through the top cap to the piston of a second valve which was partly cut open so as to show the action, any movement made in the working valve being repeated by the one above, and that he contended was direct evidence of what took place inside. He had the same apparatus now in the office of the company at Canal-road, and should be glad to show it to the author, and to anyone who might be interested. And he would then invite the author to work the brake handle himself, so as to convince him that it was not a question of skill, but that if he decreased the brake pipe pressure by, say, 5 lbs., the triple valve would make identically the same movements, and would graduate in exactly the same manner as

when he (Mr. Kapteyn), or a driver, operated the apparatus. In another part of the paper, the author said that whatever movements the triple valve made in front of the train they were certain to be very different at the rear. Now the locomotive superintendent of the Baden State Railway, who adopted this brake some years ago, had fitted up a van with an apparatus such as he had described, in order to get rid of this bugbear of the triple valve not graduating, and he was glad to say he had entirely succeeded in stamping out the erroneous conceptions that the brake could not be graduated. This van was sometimes placed in front, sometimes in the middle, and sometimes at the rear of a train of 20 carriages, which should be 200 or 250 yards from the driver, and it had often been a great delight to him, and to others, to see how accurately, and with what certainty, the triple valve responded to the operations of the driver 250 yards away, when the train was run in ordinary traffic, or when going down the enormous incline of the Black Forest line. There it was actually proved that the triple valve did the same thing at the rear of an ordinary train as it did in the front. This was sufficient to show Mr. Marshall that he was in complete error in supposing that the action was imaginary, and he would remind him of the words of Mr. John Stuart Mill—"Why spend so much trouble in calculating from imperfect data when a little study would render a conclusion certain by actual trial."

Mr. EVANS said his remarks would have regard to the action of brakes from an everyday working point of view, as opposed to what he might call the merely theoretical and mechanical side of the question. Theory was very important, but it did not enable a railway man to solve the problem which was presented to him, "What brake shall I adopt?" From the remarks made by Mr. Gutch the other evening, it might be imagined that the automatic vacuum brake was an appliance which some ingenious man had evolved out of his inner consciousness, and that it had never been in practical work, but he could inform the meeting that he had had daily experience of different forms of brakes for many years, and this was not the case. He was acting under Mr. Wright, of the Lancashire and Yorkshire, from 1876 to 1884, the time during which this question of brakes was so much agitated. The Company's vehicles, up to this time, had been equipped with the Fay brake and with Newall's, which were considered very excellent at that time, but did not meet the Board of Trade requirements. From the year 1877, several trains were fitted with various forms of brakes, viz., the Westinghouse automatic, the Smith's simple vacuum, the Sanders and Bolitho, the Eames duplex vacuum, and the automatic vacuum described by Mr. Marshall. They were not merely tried experimentally, but each class of brake was fitted to two or more trains, and ran for years in regular daily traffic. After these extensive trials, Mr. Wright decided to adopt the automatic vacuum as the best brake he could get. This was now said to be so defective that it could not be released under half a minute, and that it gave continual trouble, owing to lack of steam. As an instance of the efficiency of this brake, he would say that, in 1882, the Lancashire and Yorkshire decided to equip their Southport branch with entirely new stock, all fitted with the vacuum brake. There were twelve trains, each consisting of twelve six-wheel coaches, weighing in the aggregate about 130 tons. None of the men who worked on this portion of the line had had anything to do with the vacuum brake before, and it was rather an anxious matter with the staff when the Board expressed a wish that all these trains should be brought into service on the same day, viz., May 1st. On the previous day, the Sunday, the engines left Liverpool and Southport, light, for the carriage shops, and each engine returned with an empty train into the district, about forty miles, and the handling of the brake on this journey was all the experience any driver had before beginning regular work next day; but the whole of them came into regular service next day, and the work went on without a hitch, there was no trouble, and no delay, and the brake worked admirably. This would have been impossible with any appliance which was not both simple and efficient, and which did not release itself quickly. On that portion of the line the number of station stops was between 600 and 700 a day on 18 miles of line, and it would be impossible to do that with a sluggish brake. Since then the Lancashire and Yorkshire had fitted the whole of their new stock with this brake, and about 75 per cent. of it was now so fitted. The number of stops now being made daily with this brake on the Lancashire and Yorkshire Railway was over 7,000 on 496 miles of line, to say nothing of signal stops, of which there were many. Allowing half a minute for taking off the brake, that would mount up to 58 hours per day, which, on a railway of that character, would render traffic impossible. The Lancashire and Yorkshire traffic was second only to the Metropolitan, the passenger mileage being 12,500 a day, or more, over a length of 496 miles; and if there were not a thoroughly good brake for work of that sort, it would lead to such delays that it would be discarded at once. The brake was giving every satisfaction, and he could assure Sir Henry Tyler that he had seen a good deal of drivers, firemen, and guards, and heard their opinions, and he had never heard any complaint with regard to it. The London and South-Western used the same brake; two years ago, on that line, this brake was making about 4,000 stops a day, and since then they had largely increased the amount of their stock, and as they were running a large suburban traffic a slow brake would not do for their work. He had also had some experience abroad with the vacuum brakes, but he would not detain the meeting by going into details. With regard to the time taken in releasing, his experience was that, with average

trains of twelve or thirteen coaches the brake, after a full stop, came off in about ten seconds, and that after all ordinary stops the small ejector was quite powerful enough to release the brake in the usual time that it took to do the ordinary station duties, or when pulled up at any signal, unless there were a sudden stop, when it would take ten or twelve seconds. There was not the least cause for anxiety about loss of boiler pressure, as to which Mr. Gutch had drawn such a harrowing picture of the terrible things that might happen, but, as a matter of fact, did not happen, or if they did, on rare occasions only. If a driver got short of steam he was bound to stop and blow his fire up, or take other means to get his train on the road, and under such circumstances delays would occur, whether the train were fitted with a continuous brake or not. But the ejector would work with considerable differences of boiler pressure, and maintain the vacuum. From his own experiments he found it required a reduction of from two to two and a half inches of vacuum to balance the weights of the piston and the brake rigging, and, of course, that allowance could be made before the brakes would begin to go on, so that, if you started with 20 inches, and it was reduced to $17\frac{1}{2}$ inches, still the blocks would not be rubbing. A good deal had been said about the delay in shunting, but that was quite imaginary; there was, in fact, no delay at all; if there were, the traffic could not be carried on. But it would be infinitely preferable to suffer a slight delay rather than close a cock at either end of the carriage, and run the risk of its being left closed when coupled up again, leaving a large portion of the train with the brake inoperative. As to the ball valve, its effect was that when once the power had been created it could not be dissipated again by wilfulness, neglect, or frequent use; and that was the most valuable feature of this brake. In his opinion this lay at the root of the efficiency of all brakes; as one which could be rendered utterly inefficient through using up the power could not, other things being equal, be as efficient as one which did not use up the power under the same circumstances. At present, no doubt, the Westinghouse and the automatic vacuum were the only two in the field; both fulfilled the Board of Trade conditions, as far as he knew, but he thought there should be a further condition imposed, embodying the point he had just referred to, that the power could not be dissipated by frequent use. This condition was fulfilled by the automatic vacuum, but not by the Westinghouse. Then the anxious railway man who had to ask himself "Which brake shall I adopt?" would also inquire, "Which is the simpler?" "Which has the least mechanism to get out of order?" and "Which is the least liable to derangement from internal force?" The answer, in his opinion, would unhesitatingly be, "The automatic vacuum."

Mr. Clayton could not agree with Mr. Marshall that the Americans first introduced the automatic vacuum, for he found that there were brakes invented and tried in this country between 1853 and 1863 which would fulfil all the present requirements of the Board of Trade. But there was no doubt it was owing to the energy and enterprise of the American inventors that the agitation about continuous brakes began. Compressed-air and vacuum brakes could each be made either simple or automatic; and it was only a question of the size of the cylinder and the multiplication of leverage to bring a train going at any speed to a stop in the same distance. But the question was not which brake would bring a train to a stand in the shortest ultimate distance, but which took most speed out of the train at first. In some experiments he had been connected with, a train going at fifty miles an hour was brought to a stand in seven and a-half seconds, and those fond of adventure might repeat the experiment. All he could say was that no one could stand, those sitting facing the engine were thrown from their seats, and the train was broken into three portions. All the parts running at the same time, but at somewhat different speeds. The great conflict was between the compressed air and the vacuum, and it was mainly carried on by parties interested in one or the other system. His own device consisted of an automatic vacuum brake without a valve, or a cock, or a stuffing-box, or anything which required lubrication. On trial, it was found to answer very well, and, like some other foolish people, he thought he would patent it. Then his troubles began; it caused unpleasantness and opposition. It was this rival brake which led to the Chairman and Mr. Cowper, then President of the Institute of Mechanical Engineers, being called in to report upon the merits of the various brakes. The brake with the leak off had, up to a certain point, answered very well, and was the most convenient for working traffic. It had had one great advantage, at any rate; it had saved the vacuum brake from going to the scrap heap, and saved this country from a gigantic monopoly. The important point in a brake was early retardation, not instantaneous action, which was impossible. It took some seconds to get any brake on. He would not give figures of special experimental stops, but those derived from everyday working. For getting the automatic vacuum brake on fully, with the automatic valves in the guard's van, if the driver applied the brake fully and suddenly, he would be sure to open the automatic valves, and then the brake would be on fully in two seconds. If he did not open the automatic valve, but put it on gradually and gently, it would take 5 seconds. The quickest time in which the compressed air brake could be got on was $4\frac{1}{2}$ seconds. That meant this; with a train travelling at 50 miles an hour, in 2 seconds you get 10 tons pressure on the brake blocks with the automatic vacuum brake. In 1 second there was 5 tons on, and it took 3 seconds to get 5 tons on with the compressed-air brake. It was only when you came to the fourth second that they were equal. The value of time would be seen by remembering that 50 miles

an hour meant 75 feet per second, and 2 seconds difference of time would be of great importance in a case of emergercy.

Sir HENRY TYLER asked how many carriages there were in the train.

Mr. CLAYTON said they always took twelve carriages. From the time the brake was applied until it was on, but without much pressure, was about a second or $1\frac{1}{8}$th. The Chairman, the other evening, said that continuous brakes took about 3 miles of speed per hour out of a train per second, which was very near the result at that time; but since then it has worked out a little differently. At a speed of 50 miles an hour, it was about 2 miles per second, but it varied. In the first second you only took out half a mile of speed; in the second, 2 miles; in the third, $3\frac{1}{4}$ miles; in the fourth, 6 miles; in the fifth, 8 miles. So that in the first 5 seconds you took out 8 miles of speed; in the second 5 seconds, 11 miles; in the third 5 seconds, 14 miles; and in the fourth, when the train came to a standstill at the end of 20 seconds, 17 miles. Early retardation was the most important thing to aim at. He would have said something about the working of brakes on inclines, but time did not admit, and he might also have said something about the simple and ingenious triple valve. It could not be graduated in the way suggested in practical work. By very careful and skilful practice it might be brought to show something of the kind, but in a train running he was quite sure it could not be graduated, and if time allowed he could give reasons for that opinion, backed by experience.

The CHAIRMAN then proposed a vote of thanks to Mr. Marshall for his paper. The best proof of its excellence was that it had dissatisfied everybody. No one acting as arbitrator in a dispute could hope to satisfy both sides, and if he dissatisfied both it was probable he had done substantial justice. No one writing such a paper as Mr. Marshall's could hope to satisfy every one, and as every one seemed to think his own particular brake had not been done complete justice to, it was pretty good evidence of the impartiality of the paper.

The vote of thanks having been carried unanimously,

Mr. MARSHALL said the general result of the discussion limited the question to a comparison of the two automatic brakes, the vacuum and the compressed air, and one of the most important practical points that had been referred to was the mode of application of the power to the brake cylinders, whether direct, as in the vacuum brake, or indirect through intermediate valves, as in the compressed air brake. As regarded promptness and efficiency of working, there did not appear to be any difference of practical importance between them, some differences, as in promptness of release, referred to in the discussion being not applicable to the present brakes, but to earlier less complete forms. In respect of the indirect application of the power through intermediate valves, it had been pointed out in the paper that there was a mechanical difficulty in the supposition that a truly graduated pressure could be obtained on the brake pistons from the constant reservoir pressure by any automatic re-adjusting of the intermediate valves, and that the real action was more probably an intermittent one, the average of which amounted to the graduated pressure required. There were in this country two long inclines of 1 in 100, 15 miles length each, on the Settle and Carlisle line, which were worked with the compressed-air automatic brake, and on inquiry from the Midland Railway about the mode of working, he had received the following answer :—"In descending inclines the driver applies the brake in the ordinary manner, and when the train is sufficiently checked he has to take it off again, and apply and take off from time to time to regulate the speed of the train." In the extreme case of the Rocky Mountain incline, worked with the compressed-air brake described in the paper, 22 miles length, averaging 1 in 40, with 6 miles as steep as 1 in 27, and a portion still steeper, he had seen that the intermediate valves were all thrown out of action, and the brakes worked non-automatic during the descent; and was informed that this was the constant practice. On making inquiry of the Westinghouse Brake Company here upon the subject, giving them the particulars he had observed upon the Rocky Mountain incline, the answer was received that :—"The use of the non-automatic brake for descending long inclines is not at all necessary. On some lines in the United States there is still the practice of using the non-automatic brake for descending grades, but we think this is owing to the fact that the direct pressure brake was very largely used there before the automatic form was adopted." As this did not accord with what had been observed upon the line, he applied to the locomotive engineer of the line, asking the reason for the intermediate valves being thrown out of action in descending the incline, and his reply, which was given in the paper, is that :—"Auxiliary reservoirs cannot be re-charged without releasing all the brakes on the train, and the train will, during this short time of release—fifteen to twenty seconds—gain such a speed on a down grade of 211 feet to the mile (or 1 in 25), that it is nearly impossible to regain control over it, especially when the rail is bad. For this reason, the triple valves and auxiliary reservoirs are cut out on steep grades down." The conclusion drawn from this was that there was a limit of steepness of an incline, beyond which a brake acting through intermediate valves is not practically suitable for use; and this has been consequently included in the general conclusions given in the paper. Another point of importance in this

comparison was that, in the direct acting arrangement, there is not any discharge from the reservoir during the action of the brake, so that the store of power remains unaltered however often the brakes are put on and off; but in the indirect acting arrangement, with intermediate valves, a portion of the reservoir contents is discharged every time, and the store of power has to be kept up by replacing this loss as fast as it occurs, which involves a risk of the exhausting of the reservoir being greater than the process of re-charging can keep pace with. The essential point in a perfect brake is to have no risk of full power not being available at all times for emergency. Mr. Marshall said he was not aware of any other points calling for further remarks.

The following letter, from the Westinghouse Brake Company, has been received since the meeting:—

Much matter to the detriment of the Westinghouse brake, outside that contained in Mr. Marshall's paper, having been introduced at the adjourned discussion on Monday evening, and there having been no opportunity of reply, we beg to request that you will kindly insert the following few remarks in the ensuing number:—

First, with regard to Mr. Harold Brown, who appeared as the legal advocate of the Vacuum Brake Company. 1. Mr. Brown only referred, practically, to one of the disadvantages of his brake mentioned by Mr. Gutch, viz., that in order to fully apply the brakes, the amount of air which had to enter the pipes and cylinders of the vacuum brake, at low pressure, was forty times as much as had to flow out of the Westinghouse pipe at high pressure, and, therefore, the former must be slower in action. We have not Mr. Brown's figures, but the following calculation will justify the statement made by Mr. Gutch. The space on the underside of the piston and in the pipes when the brakes are on, may be said to amount, on an average, to 3.300 cubic inches per carriage, where a vacuum of 12 lbs. pressure is used; therefore, 2,600 cubic inches of air, at least, must flow into the pipes and cylinders of each carriage before the brakes can be fully applied. In the Westinghouse brake, on the other hand, only 20 per cent. of the pressure in the train-pipe sets the brakes with full force, or, say, 66 cubic inches, so that the volume is as 1 to 40, as stated by Mr. Gutch. With cylinders of a size to give the same brake force as the Westinghouse, of course the volumes would be increased proportionately.

2. As regards Mr. Brown's remarks on the triple valve, and the confession that it was beyond his comprehension, while we are quite ready to believe that a good deal of the ignorance with which he credited himself was assumed, there is fortunately no reason why a layman like himself should understand its working. The results of the triple valve in practice are unquestionable facts, and even supposing no one understands how they have been accomplished, it only proves that such knowledge is unnecessary. We are justified in saying, however, that there could be no excuse for any lack of comprehension on the part of those in the room on hearing Mr. Kapteyn's description of the enlarged model. As Mr. Brown is aware, Mr. Harrison, the eminent engineer-in-chief of the North Eastern Railway, and probably the most independent and highest authority on the subject, considers the triple valve simplicity itself. Referring to this gentleman's report on the amount of time occupied in cleaning triple valves, we again have not Mr. Brown's figures; but we may say that it is quite possible for such a part to receive too much attention, and our own experience proves that they can be to a great extent left to take care of themselves. It may be supposed, however, that it is not so much the attention given to the valves as the excellent results of their working, which led to Mr. Brown's remarks, for we may point out that, although the North Eastern Company had over 3,500 valves in use, only one caused delay during the six months ending December, 1885, and only four in the six months ending June, 1886, in running nearly 10,000,000 miles during the twelve months. It has been found that, taken all round, the applications of the brake average one per mile, and as there are on an average, say, ten triple valves in a train, this would make 100,000,000 movements per annum on the North Eastern Railway alone, and of these only five have resulted in trifling delay!

3. In view of the dangers pourtrayed by Mr. Brown, as likely to result from the stoppages due to burst hose, the fact that the stoppages from signals and other causes have been proved to amount to 50 per cent. over the booked stops, makes the failure of 279 hose in six months, out of more than 35,000 in use, appear unworthy of notice. Even taking those lines using the Westinghouse brake, the extra stops referred to amount to many millions a year. Mr. Marshall referred to the number of trains stopped in the course of a year from this cause, but such incidents appear very insignificant when it is remembered that they average only one in about three years for each driver. We may add that, if the railway companies found the delays of such great importance, they would probably take more care to avoid them. The hose employed with any brake will surely give way if it is allowed to remain in use until it rots; whereas, by an expenditure of about 5s. per carriage per annum, the companies might practically be free from further trouble.

4. Mr. Brown produced the stock argument of the Vacuum Brake Company, that because the Westinghouse reports in the Board of Trade Returns exceed the Vacuum, their brake must consequently be superior. Without waiting to consider wherein the merits of the vacuum brake would have consisted, had there been no reports to the Boards of Trade to manipulate, we may again protest against the

illegitimate use to which Mr. Brown puts his figures. Mr. Brown, as usual, mixes up the miles and delays of all kinds of vacuum brakes, simple, automatic, leak-hole, and Webb vacuum, and produces a very fine total; but, to be consistent, Mr. Brown, while crediting himself with the miles of other brakes which are unlike that under discussion, should debit himself with their real failures, and with the long list of killed and injured against them, such, for instance, to mention a few, as Penistone, Morpeth, Marshall Meadows, Birmingham, Portadown, &c., and we may point out that, according to the return for the half-year ending June, 1886, the Vacuum Brake Company's automatic vacuum brake, eulogised by Mr. Marshall, fitted on 3,374 carriages, ran 4,746,000 miles in the six months with 149 reports, or an average of 31,853 miles per report. The Westinghouse, fitted on 11,558 carriages, ran 18,882,000 miles with 454 reports, or an average of 41,590 miles per report. These figures include everything, even the failures of the vacuum brake on the Lancashire and Yorkshire Railway, though it is Mr. Brown's custom to omit these, because this company returns no mileage. This, however, can be taken as being the average of all other engines using the same brake. If Mr. Brown's system of comparison is to be used at all, it can only be by comparing brakes on the same principle, and in this way the Westinghouse brake appears, on Mr. Brown's principle, to be 33 per cent. better than his own, and the Fay-Newall, the chain, and the non-automatic systems, better than any others. But, although Mr. Marshall alluded to the brake return with a view of alleging some defect against the Westinghouse, he said nothing as to the nature of the reports against the vacuum, notwithstanding the paper was written with "the object solely to ascertain the means of obtaining the highest degree of efficiency and safety in railway travelling." Had Mr. Marshall analysed the returns for even the half-year ending June, 1886, he would have seen that the special parts peculiar to the Westinghouse brake give very little trouble indeed, and form only 10 per cent. of its reports, while those against the special parts of all automatic vacuum brakes are 76 per cent. The remaining 90 per cent. of the Westinghouse are due to burst pipes and slight leakage, as well as to carelessness and inexperience of servants. Taking the special parts as fitted on an engine tender and carriage of the Westinghouse, and the corresponding parts of the automatic vacuum systems, the numbers against the former are 48 reports in running nearly 19,000,000 miles, and against the latter 226 in running over 16,000,000 miles. Amongst other cases against the vacuum there are 48 cases of stuffing-boxes and their equivalent miniature sacks causing delay; a source of trouble from which the Westinghouse is quite free, such a part not being required. There are 31 cases of pistons and rolling rings against 2 for the Westinghouse. The rolling rubber ring hardly bears out Mr. Marshall's eulogy. It may not require lubrication, but that something is wanted is clear, from the fact that it causes considerable delay, four cases alone on the Lancashire and Yorkshire Railway, averaging half-an-hour a piece, viz., on January 23rd, May 25th, June 1st, June 19th. There are also some bad cases on the Midland Railway, and on May 19th, Ashchurch platform is reported to have been overrun owing to the rolling ring being broken. Of guard's inlet valves there are 11 cases against none for the Westinghouse. The author says that in the vacuum brake "it is requisite to avoid any accumulation of water for preventing a risk of obstruction from the formation of ice." That this is no idle fear is shown very plainly in the returns, from which it would appear that all vacuum brakes suffer considerably from ice or water, there being no less than 45 cases against them; those against the automatic system alone have caused 243 minutes delay. The only incident of the kind against the Westinghouse is a delay of three minutes, owing to the self-application of the brake through the bursting of a cup on a tender. There are a number of reports from the Great Western, Lancashire and Yorkshire, and London and South-Western Railways, caused by the vacuum pipe being choked with ice. What the consequence of this might be is evident from the report on the collision which occurred on December 21st last outside Carlisle Station. A London and North-Western train ran 300 yards past its usual stopping place, and after colliding with a Midland engine, came to a stand 180 yards farther on. It was found that the brake pipes between the engine and tender were completely blocked with a plug of ice, thus rendering the vacuum brake useless. This was not an automatic vacuum, but had it been so the pipe would still have frozen. On November 29th, 1884, a Midland train, fitted with the automatic vacuum brake, ran through Nottingham Station, also due to the pipe between engine and tender being obstructed from the same cause. This case is reported in the Board of Trade Returns for December, 1884. This serious defect of vacuum brakes is due to the condensation of the enormous volumes of air required to operate the brakes, and the natural tendency to create ice in rarified vessels.

The length of the delays in the vacuum compared with the Westinghouse is very striking. Even the leak-hole system on the Great Western Railway is subject to delays of 20, 17, and 13 minutes. The Lancashire and Yorkshire, and the London and South-Western Railways, are the principal users of the vacuum ball-valve brake, and these two lines average nearly 6½ minutes per report, and run nearly 4,000,000 miles at the cost of 904 minutes, or an average of 4,352 miles per minute. On the other hand, the London and Brighton. and Caledonian Railways (to get an approximate number of miles for the purpose of comparison) ran, with the Westinghouse, nearly 5,500,000 miles, at a cost of 198 minutes, which gives an average of 27,404 miles

per minute, or a proportion of over six to one compared with the vacuum on the Lancashire and Yorkshire, and London and South-Western. If we take the Westinghouse all round, we find it runs nearly 19,000,000 of miles for 454 reports, and an average of 10,000 miles for a delay of one minute; whereas the Vacuum Brake Company's brake runs 4,750,000 miles for 149 reports, and has an average of only 5,000 miles per minute.

5. Mr. Brown of course also refers to the Blackburn collision. Such an allusion in reality only shows the bareness of his client's case. We need only say here that, as everyone knows, the Westinghouse brake had nothing whatever to do with the accident. It was solely due, as the jury found, to the want of proper signals, and to the recklessness of the driver; several passengers in the train having sworn that they felt the brake on, but of course it was applied too late. No one was hurt in the Westinghouse train; but, had the brake not acted, there must have been a sacrifice, perhaps as great as that at Penistone in July, 1884, where, owing to the failure of the vacuum brake, 24 people were killed, and 64 injured. That Col. Yolland's report on the Blackburn collision had anything to do with the Lancashire and Yorkshire Company refusing the Westinghouse and accepting the vacuum, is also a statement which Mr. Brown can hardly credit, and for the following reasons:— The Euston meeting took place on April 2nd, 1881, at which Mr. Barton Wright, Locomotive Superintendent of the Lancashire and Yorkshire Railway, voted in favour of the Automatic Vacuum Brake. The directors subsequently, about June, 1881, ordered the new trains for the Liverpool and Southport branch, fitted with the vacuum brake; the Blackburn collision took place on August 8th, 1881, and Col. Yolland's report was not issued until the middle of January, 1882. Neither Mr. Barton Wright's vote in April, nor the directors' adoption of the vacuum brake soon after, could have been influenced by an incident which occurred in August, and still less by a report which was issued six months later. The reason for the action of the Lancashire and Yorkshire Company had a very different origin, as Mr. Barton Wright can inform Mr. Brown.

As regards Mr. Evans's remarks, his experience of the working of the vacuum brake on the Lancashire and Yorkshire Railway would have been of more value (1) had he not left the service of the company soon after its introduction, and remained abroad for some years; (2) the Lancashire and Yorkshire is a line where the trains have very short runs (we believe the longest is only 54 miles), and the trains, as a rule, comparatively short. Mr. Gutch never maintained that the automatic vacuum brake could not be worked fairly well on trains of ten carriages, but the difficulty of working this brake is immensely increased when ten or twelve coaches is exceeded. As to thirty seconds not being required to release the brakes, Mr. Gutch said this was so when the brake was fully applied, and he founded his statement on the fact that the Vacuum Brake Company themselves state that it takes 30 seconds to remake a vacuum of 20 inches. If the brake has been only partially applied for an ordinary stop, of course it will come off sooner, but as Mr. Evans knows, it is the last inch which seems so long in coming. Mr. Gutch adheres to his statements as to the delay and difficulties in consequence of the application of the brakes when the couplings are disconnected, and he refers Mr. Evans to Mr. Clayton's specifications, Nos. 946, of 1878, and 593, of 1879, as a proof of this, as well as of the slow process of creating a vacuum. Mr. Clayton also speaks of effects of leakage in the train-pipe, and the Board of Trade Returns have many cases of delay from this cause. The returns from the Lancashire and Yorkshire Railway referred to above hardly bear out Mr. Evans's contentions as to the working of the vacuum brake on that line. As regards the cocks in the train-pipe of the Westinghouse brake, these are a great saving of air and time, and have more than once been the means of saving life. At North Wootton, on September 3rd, 1884, the fact of a store of power remaining on the carriages when the engine was unfitted with the brake, no doubt saved many lives. Under similar circumstances, the vacuum brake could be of as little service as if the train had not been fitted at all.

As regards Mr. Clayton, neither his facts nor his figures are unimpeachable, so far as his remarks were audible. Not having his figures before us, it is impossible to criticise them minutely, but we gathered that Mr. Clayton claimed that whereas his brake was full on in two seconds at the end of twelve coaches, the Westinghouse took four and a quarter seconds, and that while the vacuum brake was applied with five tons in one second, the Westinghouse could only get five tons in three seconds. Whether this result was in any way due to the somewhat crude and novel method of making the experiment, so humorously described by Mr. Clayton, we do not know, but perhaps Mr. Clayton will explain how it was that at Captain Douglas Galton's trials on the Lancashire and Yorkshire Railway in July, 1880, when the Westinghouse was tried against the Eames and the Sanders' automatic vacuum brakes, the average of the stops when the train was slipped from the engine at fifty miles per hour, was as follows:—

Eames	754 feet.
Sanders	722 ,,
Westinghouse	441 ,,

Our explanation is that the experiments were made by an independent person, who used a recording indicator, by which a diagram showing the speed and the distance was taken, and afterwards embodied in the report. Mr. Clayton produced no diagrams, and appears only to have ventured to get his results from trains when at rest. It will be noted that Mr. Clayton avoided any explanation as to the importance of having a leak-hole at one time and not at another, or how the disadvantages in the Sanders-Bolitho auto-

matic vacuum brake, as described in his specifications, have ceased to exist in a brake which is to all intents and purposes the same.

Mr. Marshall, in summing up, made no reference to the various objections against the vacuum brake, and declined to credit the functions and operation attributed to the triple valve. As Mr. Marshall refuses to put the question of the graduation of the triple valve to a test, we need say no more, except that his reference to the portion of the line between Settle and Carlisle is entirely beside the mark. It is quite possible that drivers do apply and release the brake occasionally in the way described, but this is only because nothing further is required. A gradient of 1 in 100 really requires no continuous brakes at all, so far as preventing the train reaching excessive speed is concerned, and it is a fact that this portion of the Midland Railway is used by the drivers for hard running and making up time; but the brakes are found very useful even for this purpose, since they enable the driver to exceed his ordinary speed, and giving him the power of checking it promptly at curves and other places, thereby saving much time.

Space will not allow us to set forth at length all the disadvantages of the automatic vacuum brake, ignored by Mr. Marshall, such, for instance, as the immense loss of effective pressure which results from a comparatively small reduction of initial vacuum; and also the continued loss of power in proportion as the stroke of the piston, due to the wear and tear of the brake-blocks, diminished the capacity of the reservoir; as well as its impracticability for working on goods trains. We will only say that vacuum affords no advantage whatever over pressure for working brakes, and that had the differential piston system not been open to great objections, Mr. Westinghouse might have been satisfied with his first form of automatic brakes, and there would have been no occasion for such an immense improvement as the triple valve.

We are, Sir,
Yours faithfully,
THE WESTINGHOUSE BRAKE COMPANY, Ltd.
(ALF. KAPTEYN, Manager & Sec.)
Canal-road, King's-cross, London, N.
March 16th, 1886.

Miscellaneous.

IMPERIAL INSTITUTE.

An outline of the proposed Intelligence Department for Industries, Commerce, Technical and Commercial Education, and Emigration, as part of the working details of the Imperial Institute, has been issued, from which the following particulars have been extracted:—

It is anticipated that the objects of the Institute will be secured in an effectual manner by establishing a highly organised Intelligence Department as a leading feature in this important undertaking. An example of the successful working and organisation of an Intelligence Department is furnished by the Intelligence Branch of the War-office, in harmony with which a Naval Intelligence Department has recently been established by the Admiralty. In illustration of the working of such a Department, it may be stated that, for the purposes of systematic working, the War-office establishment is divided into seven sections, of which six correspond with different portions of the globe, the seventh being occupied with the production of maps and the care of a library of reference. Each section has its special head, who is selected as having a particular acquaintance with the affairs and languages of the countries which his division represents. Under the sectional officer are employed one or more similarly selected juniors, and a suitable staff of assistants, and the entire organisation is under the charge of a specially qualified senior officer, who acts as the Director of this Department. The frequent necessity of secrecy in its work prevents the military department from publicly seeking or giving information, by means of conferences or lectures, but this want is supplied to the military and naval professions by the Royal United Service Institution, a Society which provides for lectures and discussions on questions of current interest, publishes valuable reports and papers, and maintains a library and map room, and an interesting museum of military and naval inventions and illustrations.

Without going into details of arrangement of such an Intelligence Department, it may be indicated that its operations will probably be embraced within four chief sections, dealing respectively with industries, commerce, technical and commercial education, and emigration, and that it will be in intimate relation with local chambers of commerce, with commercial museums and technical colleges in the metropolis and the provinces, and with inquiry and reference offices widely distributed over the United Kingdom, the Colonies, and India. The Institute will, in fact, be the head centre whence information relating to the above subjects, continually and systematically collected by means of the system of organisation which has been indicated, will be disseminated throughout the Empire through the medium of the principal commercial and industrial centres, and its establishment will thus lead to the interchange and continual advancement of knowledge bearing directly upon the prosperity of the Empire, among all classes and races of her Majesty's subjects.

Obituary.

CAPTAIN JAMES BUCHANAN EADS, the distinguished American engineer, who died at Nassau, New Providence, on Tuesday, 8th inst., was born a

Lawrenceburg, Indiana, on May 23, 1820. On leaving school he was employed in a store, and subsequently became a clerk on a Mississippi steamboat. He devoted his leisure to the study of engineering, and in 1842 constructed a diving-bell boat for the recovery of cargoes of sunken steamers. In 1861, he was consulted by Presid nt Lincoln as to the best means for opening up the navigation of the Mississippi, and he designed and completed for the Government a squadron of eight light-draught iron-clad vessels for service on that river. Between 1867 and 1874 he designed and constructed the great steel bridge across the Mississippi at St. Louis. He was then intrusted with the important task of improving the channel of the Mississippi below New Orleans, which was seriously obstructed. In the space of five years, by his ingenious operations, he secured a channel 200 ft. wide and 26 ft. deep, with a central depth of not less than 30 ft. Captain Eads also advocated the application of the jetty system to the improvement of the channel of the Mississippi as far north as St. Louis, and this undertaking has now been carried out. One of the projects advocated by Captain Eads was the construction of a ship-railway across the Isthmus of Tehuantepec. In 1884, he rsigned his position in connection with the Mississippi Improvement Commission. In the same year the Council of the Society of Arts awarded the Albert Medal to Captain Eads, "whose works have been of such great service in improving the water communication of North America, and have hereby rendered valuable aid to the commerce of the world," and on the 11th of July the medal was presented to Captain Eads by H.R.H. the Prince of Wales, at Marlborough House. Captain Eads was also elected a member of the Society in 1884.

Sir William Patrick Andrew, C.I.E., died on Friday last, 11th inst, in the 81st year of his age. He was born in Aberdeenshire, and was educated at Edinburgh and Oxford. He served in early life for a short period in India, and submitted to the Home Government his schemes for the defence of India, which afterwards met with approval. He was founder of the Scinde, Punjaub, and Delhi Railway Company, and took an early and prominent part in promoting railway and telegraphic communication with India. Among the works of which he was the author were "Indian Railways," 1846; an essay on the Scinde Railway in relation to the routes to India: a letter to Lord Palmerston on the Euphrates Valley Railway; letters reprinted from *The Times* on telepraphic communication with India, 1856; and several other articles on Indian railways and the route to India; "Colonisation in India and Australia compared;" "India and her Neighbours" (1878), in which he pointed out that England possessed more Mahomedan subjects than the Sultan and the Shah together. In 1856, he concluded an arrangement with the Home Government for the establishment of telegraphic communication with India, and in the following year he advocated on strategic grounds the construction of lines to the Bolan and the Khyber. In 1873, he led the discussion on the question of the gauge of Indian railways—a subject he had already treated in pamphlets—at the meeting of the Institution of Civil Engineers at Westminster, when a resolution in favour of his views with regard to a gauge of 5 ft. 6 in. was passed by a large majority. The great scheme of Sir William Andrew's life was the Euphrates Valley Railway, and upon this scheme he read a paper before the Society of Arts, in February, 1880, on which occasion the late Field-Marshal Lord Strathnairn presided. Sir William Andrew had previously read a paper before the Society on "Railways in India" (1870). He also took the chair, and spoke, in the discussions at several of the Society's meetings. He was elected a member of the Society in 1860, and was knighted in 1882, when he received the Companionship of the Order of the Indian Empire.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

March 23.—"Some of the Conditions Affecting the Distribution of Micro-Organisms in the Atmosphere." By Dr. Percy Frankland. Prof. J. Burdon Sanderson, M.A., M.D., LL.D., F.R.S., will preside.

March 30.—"Electric Locomotion." By A. Reckenzaun.

The dates for the following Papers are not yet fixed:—

"Cottage Industries in Ireland." By Mrs. Ernest Hart.

"Miners' Safety Lamps." By Edward H. Liveing.

"Development of the Mercurial Air-pump." By Prof. Silvanus P. Thompson, D.Sc.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. Cross.

"Progress in Telegraphy." By William Henry Preece, F.R.S.

"Agricultural Education." By J. C. Morton.

Indian Section.

Friday evenings, at Eight o'clock:—

March 25.—"Indian Coffee." By Frederick Clifford. Major-General Michael, C.S.I., will preside.

April 29.—"Village Communities in India." By J. F. Hewitt.

May 27.—"Indian Tea." By Dr. T. Berry White. H. S. King, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29—"Colonial Wines." By RICHARD BANNISTER.

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

MAY 17.—"The West Indies." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN.

MAY 10.—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

These dates are liable to alteration.

CANTOR LECTURES.

The Fourth Course will be on "Machines for Testing Materials, especially Iron and Steel." By Prof. W. C. UNWIN, F.R.S. Three Lectures.

LECTURE I.—MARCH 21.—Objects of testing materials.—Scientific and commercial objects.—Strictly relative character of ordinary testing.—Elasticity and plasticity.—Tension and compression. Behaviour of brittle and ductile materials.—Stress-strain diagrams.—Classifications of testing machines. Arrangement of testing machines.—Weighing apparatus.—Straining apparatus.—Knife edges.—Description of some typical machines.—Greenwood and Batley machine.—Wicksteed machine.—Grafenstaden machine.—Werder machine.

LECTURE II.—MARCH 28.—Maillard and emery machines.—Large machines without levers.—The Union Bridge Company's machine.—Methods of holding specimens.—Forms of specimens.—Measuring apparatus.

LECTURE III.—APRIL 4.—Tests of other kinds.—Shearing and crushing tests.—Tests of stone and cement.—Smaller testing machines.—Endurance tests. Relations between mechanical tests and chemical properties and modes of manufacture. Circumstances which affect the results of tests.

The Fifth and Concluding Course will be on "The Chemical Changes of Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. C. Unwin, "Machines for Testing Materials, especially Iron and Steel." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Mr. P. E. Pilditch, "Notes on Dilapidation Practice." 2. Discussion on Mr. Wheeler's paper, "Dilapidations, and the Legal Obligation to Repair."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m. Mr. Isaac Shone, "The Hydro-Pneumatic Drainage of the Houses of Parliament."

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. R. Collins, "Krishna and Solar Myths."

TUESDAY, MARCH 22...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture X.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on Colonel E. Maitland's paper, "The Treatment of Gun-Steel."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Dr. H. Rink, "The Migrations of the Eskimo." 2. Mr. Coutts Trotter, "Notes on the Inhabitants of the Polynesian Islands." 3. Lieut. F. Elton, "Extracts from Notes on Natives of the Solomon Islands."

WEDNESDAY, MARCH 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Percy Frankland, "Some of the Conditions affecting the Distribution of Micro-organisms in the Atmosphere."

Geological, Burlington-house, W., 8 p.m. 1. Prof. T. G. Bonney, "Notes on the Structures and Relations of some of the older Rocks of Brittany." 2. Rev. E. Hill, "The Rocks of Sark, Herm, and Jethou." 3. Mr. James Radcliffe, "Quartzite Boulders and Grooves in the Roger Mine at Dukinfield."

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Spring Exhibition.

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, MARCH 24...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. Max Müller, "The Science of Thought." (Lecture II.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. A. E. Kennelly, "The Resistance of Faults in Submarine Cables."

FRIDAY, MARCH 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. Frederick Clifford, "Indian Coffee."

United Service Institute, Whitehall-yard, 3 p.m. Captain P. H. Colomb, "Convoys; are they any longer possible?"

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Lord Rayleigh, "Colour of Thin Plates."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Papers by Miss Whitehead and Prof. Corson.

SATURDAY, MARCH 26...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. C. V. Boys, "The Production of the Finest Fibres." 2. Prof. Pickering, "Delicate Calometrical Thermometers, and the Expansion of Thermometer Bulbs under Pressure."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Sound." (Lecture V.)

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FRIDAY, MARCH 25, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list of subscriptions by members of the Society of Arts to the funds for the Imperial Institute since the list published in the last number of the *Journal*:—

	£	s.	d.
William Henry Barlow, F.R.S., Member of Council	26	5	0
William Brigg	1	1	0
William Walter Brocklehurst	5	0	0
John J. Cater	1	1	0
Robert A. Douglas	1	1	0
Silas E. Martyn	5	0	0
Stephen J. Newman	1	1	0
Gilbert Purvis	1	1	0
Gysbertus Welling	1	1	0
Amounts previously acknowledged	2,070	4	0
Total	£2,122	15	0

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

MOTORS FOR ELECTRIC LIGHTING.

The Council regret to have to announce that the number of motors entered for the tests which the Society proposed to hold is, in their opinion, insufficient to ensure a satisfactory trial of the motors generally employed for electric lighting.

They have, therefore, decided to postpone the competition till next year, in the hope that longer notice may induce a larger number of entries.

They now propose, if a sufficient number of motors are entered, to hold the trial in the spring of 1888.

Entries will be received up to the 31st December of this year.

The conditions of the competition will be the same as those previously published, subject to any alteration which may be announced in the *Journal.*

DR. PERCY FRANKLAND'S PAPER.

The discussion on Dr. P. Frankland's paper on the "Distribution of Micro-Organisms in the Atmosphere," on Wednesday evening, 23rd inst., was adjourned to Wednesday evening next, 30th inst., when Dr. Burdon Sanderson will preside.

COLONIAL AND INDIAN EXHIBITION REPORTS.

The Reports on the Colonial Sections of the Exhibition, prepared under the direction of the Council of the Society, at the request of H.R.H. the Prince of Wales, Executive President of the Exhibition, and President of the Society, are now ready. The following is a list of the reports:—

1. Mining Industries. By C. Le Neve Foster.
2. Minerals and Gems. By J. Reynolds Gregory.
3. Meat and Dairy Products. By Clare Sewell Read.
4. Grain. By W. Proctor Baker.
5. Fruits. By D. Morris.
6. Tea. By A. G. Stanton.
7. Coffee. By H. Pasteur.
8. Cocoa. By H. Pasteur.
9. Sugar. By Neville Lubbock.
10. Wines, Spirits, Beer, and other Fermented Liquors. By R. Bannister.
11. Tobacco. By G. Watt and John McCarthy.
12. Drugs, Chemical and Pharmaceutical Products. By B. H. Paul.
13. Oils and Fats. By Leopold Field.
14. Gums, Resins, and Analogous Substances. By Thomas Bolas.
15. Cotton. By J. Butterworth.
16. Wools. By F. H. Bowman.
17. Silk. By T. Wardle.
18. Miscellaneous Fibres. By C. F. Cross.
19. Leather, Leather Goods, Furs, Hides, and Tanning Materials. By J. Powell.
20. Timber (No. I.). By T. Laslett.
21. Timber (No. II.). By Allen Ransome.
22. Machinery. By W. Anderson.
23. Musical Instruments. By John Stainer.

The volume is published by Messrs. Clowes and Sons, price 10s. 6d. Members of the Society can obtain copies at a reduced price, 8s., by applying to the Secretary.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1887 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before 16th April, the names of such men of high distinction as they may think worthy of this honour. This medal was struck to re-

ward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follow :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1886, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electiicity, magnetism, and chemisty, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.. "for the invention and manufacture of instruments of measure and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michael Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture, have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and a Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate

knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communication of North America, and have hereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Mr. Samuel Cunliffe Lister, "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

CANTOR LECTURES.

On Monday evening, 21st inst., Professor W. C. Unwin, F.R.S., delivered the first of his course of Cantor Lectures on "Machines for Testing Materials, especially Iron and Steel."

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. Barrett, Mus.Bac., Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing Monday, 23rd May, 1887.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 23rd, 1887; Professor J. Burdon Sanderson, M.A., M.D., LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barnett, William, Court-street, Faversham, Kent.
Breeds, Thomas, 11, Albany-rd-, St. Leonards-on-Sea.
Cowan, Edward, 4, Cazenove-road, N.
Greaves, John Arthur Robert, 12, Shobnall-road, Burton-on-Trent.
Kemp, David Skinner, 27, Coverdale-road, Shepherd's-bush, W.
Soper, Arthur L., 7, Cholmeley-park-villas, Highgate, N.
Warren, Thomas T. P. Bruce, Tamworth-villa, Earlham-grove, Forest-gate, E.
Whaley, John, 9, Furnival's-inn, E.C.
Wroughton, William M., Creaton-lodge, Northampton, and 30, Chester-square, S.W.

The following candidates were balloted for and duly elected members of the Society.

Harris, George David, 32, Inverness-terrace, W.
Jarvis, John Edmund, 39, Victoria-road, Kensington, W.
Kell, Robert, St. George's Club, Hanover-square, W.
Lee, Henry Austen, Foreign-office, S.W.
Lile, John Henry, Devon-house, Brixton-hill, S.W.
Paget, George Edmund, M.A., 3, Sutherland-terrace, Westbourne-park, W.
Rickatson, William Henry, 6, Ridinghouse-street, Langham-place, W.

The paper read was—

SOME OF THE CONDITIONS AFFECTING THE DISTRIBUTION OF MICRO-ORGANISMS IN THE ATMOSPHERE.

By Percy F. Frankland,
Ph.D., B.Sc. (Lond.), F.C.S., F.I.C., Assoc. Royal School of Mines.

That the air we breathe is more or less laden with living organisms is a fact which is far from acceptable to most persons, and yet it would require but little persuasion to convince the majority of mankind that air without organisms would be undesirable indeed; for without one micro-organism at least, which is very widely distributed in the air, we should have to forego those numerous, complex, and much appreciated pleasures which are derived from the consumption of alcohol in its various forms. How many would vote the earth flat and stale but for the products which are alone elaborated by *yeast*, which was the first micro-organism to receive attention, and which, in spite of the many powerfully organised endeavours to undermine its position, is likely also to be the last to absorb the interest of man.

But there are other micro-organisms in the air besides yeast, and it is the firm conviction that many zymotic diseases are propagated by means of air-carried microbes, that renders the investigation of the subject of aërial micro-organisms peculiarly interesting and attractive.

Passing over a number of isolated observations by Leeuwenhoek, Ehrenberg, and Gaultier de Claubry, the systematic examination of the aërial microbia commences with those marvellous discoveries with which the name of Pasteur is so inseparably connected, and with which the latter half of the 19th century will for ever be associated.

These now classical researches of Pasteur's on the presence of micro-organisms in the atmosphere, were undertaken in connection with the fierce controversy which raged, some

thirty years ago, on the "*Spontaneous Generation of Life.*"

As most of you are doubtless aware, it was contended by the teachers of this doctrine that the presence of the smallest particle of air was sufficient to determine the generation of low forms of life in certain highly putrescible substances, such as milk, blood, infusions of meat, and the like. The opponents of this doctrine, marshalled by M. Pasteur, contended, on the other hand, that it was not the air, but certain living germs suspended in the air, which, gaining access to these putrescible materials, gave rise to those growths which make their appearance in them.

"Were this the case," replied his antagonists, the preachers of spontaneous generation, "these aërial germs would give rise to a fog as opaque and impenetrable as steel." But Pasteur's convictions were not to be shaken by dogmatic and baseless assertions of this kind, and he therefore undertook to prove his case by experiments so clinching and unanswerable, that they could leave no shadow of doubt in any unbiassed mind.

Pasteur's Experiments.

The methods by which Pasteur not only revealed the presence of micro-organisms in the atmosphere, but, at the same time, roughly mapped out their distribution, are so striking in their beautiful simplicity, that I must, at the risk of being charged with telling an old tale, refer to them in more detail than might appear warrantable.

Pasteur's Apparatus.—The apparatus employed by Pasteur for this purpose consisted of a number of small flasks, such as you see here. Into these flasks, which were about one-quarter litre capacity, was introduced a small quantity of what is known as a *cultivating medium*, *i.e.*, a material in which these lower forms of life are capable of flourishing and multiplying abundantly. The cultivating medium employed in this case was clear broth, which forms an excellent nourishing material for the greater number of known micro-organisms. The necks of these flasks were then drawn out to a fine aperture, and the contents heated to boiling for some time, with the double object of *sterilising*, or destroying, any living matter in the culture-medium on the one hand, and, on the other, of expelling the air from the flask. The open extremity of the flask was then sealed with the blowpipe, whilst steam was still issuing from the mouth. Pasteur found that the cultivating material in flasks thus prepared remained sterile for an indefinite period of time, and by this and numerous other experiments, into which I cannot enter here, conclusively disproved the theory of the spontaneous generation of these lower forms of life.

With a collection of flasks of this kind, Pasteur then explored the atmosphere of a number of different places. For, by breaking off the drawn-out extremities of the flasks in any given place, the vacuum inside the flask is immediately filled with a sample of the air in question, with all that it holds in suspension. The broken point is then immediately re-sealed before the blowpipe, and on preserving the flask at a suitable temperature for a few weeks, the presence of any living organism which has gained access along with the air will become revealed by its growth in the broth rendering the latter turbid.

Now Pasteur exposed

20 flasks in the open country of Arbois.

20 more on the lower heights of the Jura Mountains.

20 more at the Montanvert, close to the Mer de Glace, at a height of upwards of 6,000 feet.

These three series of samples were deposited by Pasteur in the bureau of the Academy of Sciences, in the month of November, 1860. The result, which was awaited with the utmost interest by the numerous *savants* who had taken part in the previous discussions, was as follows:—

Of the 20 flasks opened in Arbois, 8 developed living organisms.

Of the 20 flasks opened on the Jura, 5 became affected.

Whilst of the 20 flasks opened on the Montanvert, only 1 broke down.

These results speak for themselves, and require no comment.

Tyndall's Experiments.

These investigations were not, however, confined to France, for in this country the subject was, as is well known, pursued by Professor Burdon Sanderson, Sir Joseph Lister, Dr. Tyndall, and Professor Lankester, to all of whom we are indebted for so much of our knowledge concerning the conditions of life of these lower organisms. It is, however, with Dr. Tyndall's researches on aërial micro-organisms that we are more particularly concerned this evening. Tyndall's experiments were more especially directed towards tracing the connection between some of the optical

properties of air and the presence of living organisms in it.

As is well known, that when a powerful beam of light is passed through the air of an ordinary room, the path of the beam is rendered visible by the illumination of a vast multitude of floating particles. Now, Tyndall found that if the air in an enclosed chamber be allowed to remain at rest for some time, and a beam of light is then passed through the chamber, its path is no longer visible, the air within the chamber being free from suspended particles capable of reflecting and dispersing the light of the beam. He further showed that this "moteless air," as he called it, was incapable of causing alteration in boiled broth and other cultivating media, or, in short, that the moteless air was sterile or free from micro-organisms.

The great importance of these experiments lies in the conclusive demonstration which they yield, of the comparatively short time which is required for suspended micro-organisms to subside in calm air, to which point we shall have occasion to refer again subsequently.

Miquel and Freudenreich's Experiments.

We must now pass on to those endeavours which have been made to demonstrate the actual number of living micro-organisms present *in a given volume of air*, attempts in fact to raise the examination of air for micro-organisms from a *qualitative* to a *quantitative* one.

As we have noticed, in Pasteur's experiments already a certain indication was obtained of the relative abundance of micro-organisms in the air of different places, but these experiments made no pretensions to indicating the actual number of organisms present in a given volume of air. Pasteur's results simply show that there were less organisms in a given volume of air collected on the Montanvert than in the same volume of air collected at a lower altitude, but they make no claim to determining the actual number of organisms in a cubic foot or any other given volume of the air of any of the places referred to.

The experiments of Miquel and Freudenreich, however, lay claim to revealing, with more or less accuracy, the actual number of organisms present in a given volume of air, and we must now examine the basis upon which the claim of these investigators rests.

The principal method which these experimenters have devised for examining the air for micro-organisms, consists in aspirating a certain volume of air through a small plug of glass wool, in passing through which the suspended matter, including any micro-organisms, are arrested. The plug of glass wool is then thoroughly mixed with a certain volume of sterilised water. The mixture thus obtained is then subdivided into such a number of equal parts that each part shall contain not more than one organism. Each of these subdivisions is then introduced into a tube or flask containing sterile broth. These tubes or flasks are then preserved at a suitable temperature, and any that have received a living organism will, in course of time, exhibit the fact by suffering visible alteration. Thus, supposing the plug through which 100 litres of air was drawn was mixed with 50 cubic centimetres of water, and a series of 50 tubes of broth were then each inoculated with 1 cubic centimetre of this mixture, and if then on keeping these 50 tubes at a suitable temperature it was found that only 40 of them suffered alteration, it would be concluded by Miquel and Freudenreich that only 40 organisms were present in the 50 cubic centimetres of water distributed amongst the 50 tubes, or, in other words, that the 100 litres of air contained 40 living organisms.

This method, which is extremely ingenious, and which is, perhaps, as perfect as a method in which a liquid cultivating medium is employed can be, still labours under defects which at the present time are altogether inadmissible.

The grave defect of this process consists in the difficulty of mixing, and equally distributing the micro-organisms collected on the plug of glass wool. Thus, in the first place, if the mixture is not sufficiently subdivided, or in other words, if the whole of the tubes into which the subdivided mixture is inoculated become affected, there is obviously no possibility of estimating the number of organisms present, for there is no evidence as to whether each tube succumbed to the presence of a single organism, or to the presence of several. In this case the experiment is entirely lost, and all the care and trouble expended in its execution wasted.

But, even if the experiment is successful, and only a part of the inoculated tubes become affected, it is obvious that the deductions made from the result are not necessarily true, for it is only an assumption that each of the tubes affected has become so from the introduction of a single organism. As is well known to all

who have practical experience in these matters, it is frequently quite impossible to secure an even distribution of organisms in a liquid containing suspended matter, such as the glass wool in the present instance. There is, in fact, no guarantee that the affected tubes have not succumbed in each case to more than one organism, and that, consequently, the subsequent calculation as to the number of microbes in the air operated on is not involved in serious error.

By means of this process, however, Miquel and Freudenreich have carried out a very large number of experiments on the presence of micro-organisms in the atmosphere, and the results are doubtless fairly comparable *inter se*.

Solid Cultivating Media.

The enormous progress which has, during the last ten years, been made in the study of micro-organisms is undoubtedly due to the far greater facilities which are now afforded by the beautiful methods of cultivation which have been so prominently brought before the scientific world by the masterly researches of Robert Koch. As might be anticipated, these methods of investigation, which enable all studies in connection with micro-organisms to be carried on with an exactitude and rapidity which was quite beyond the reach of the older observers, have also entirely altered the problem of approaching the micro-organisms present in the atmosphere.

The fundamental principles underlying the modern methods of bacteriological study, are the substitution of solid for liquid cultivating media, and the isolation of micro-organisms by plate-cultivation.

The first adaptation of these new methods to the investigation of the micro-organisms of the air, was made by Koch, who exposed dishes containing sterile solid cultivating material to the air, the organisms falling upon which subsequently gave rise, by their growth and multiplication, to visible colonies often possessing characteristic appearances. If the dishes are exposed to the air for a suitable length of time, the colonies resulting from the deposited organisms are sufficiently distant from each other to prevent their mutual interference. The number of these colonies can be readily counted, and the organisms belonging to each colony separately studied.

The number of colonies on dishes thus exposed gives no clue as to the number of micro-organisms present in a given volume of air, but only as to the number of organisms falling on a given surface in a given length of time. There exists, however, no better method than this for simply collecting organisms from the air, as in this manner pure cultivations of the various aërial microbes are obtained with the greatest facility. The exposure of such surfaces of solid culture materials at once added a very important point to our knowledge concerning the occurrence of micro-organisms in the air, for it was found that the colonies developing on surfaces are almost invariably pure cultivations—*i.e.*, the individual organisms constituting each particular colony are all of the same kind—thus clearly showing that the different varieties of organisms present in the air are separated from each other, and do not occur adhering together.

Hesse's Method.

The solid cultivating media were first adapted by Hesse to determining the number of micro-organisms in a given volume of air. Hesse made the very remarkable discovery that, if air is slowly drawn through tubes of wide diameter, practically the whole of the micro-organisms suspended in the air are deposited within a very short distance, thus confirming and extending the observations which had been previously made by Tyndall in the case of his closed chambers.

In order to turn this remarkable gravitating property of aërial micro-organisms to account, Hesse constructed tubes, of about 3 ft. in length and 1½ in. in diameter; these tubes were internally coated with a solid layer of sterile gelatine-peptone. Protected by means of an india-rubber cap at one end, and a cork with a glass tube plugged with cotton wool at the other, the internal coating of gelatine remains unaltered for an indefinite period of time; but when the tube is to be used, the india-rubber cap is removed, and an aspirator attached to the glass tube at the other exremity, by means of which a slow current of air—about one litre in two to three minutes—is drawn through the tube.

The number of litres aspirated depends upon the comparative richness or poverty in microbes which experience leads one to anticipate that the air under examination will possess. For if there are only few organisms in the air, it is desirable to aspirate a considerable volume, perhaps twenty litres or more, whilst if the air is highly charged with microbes, a smaller volume must be taken, otherwise the resulting

colonies in the tube will be so densely packed that they may interfere with each other.

After a definite volume of air has been drawn through the tube, the cap is replaced, and the tube kept at a suitable temperature for several days. On then inspecting the tube, it will be found to present a highly interesting appearance. The inside of the tube contains a number of colonies, each resulting from an organism which was deposited on the surface of the gelatine during the aspiration of the air.

Two highly characteristic points with regard to the distribution of these colonies at once strike the observer.

In the first place, the colonies are not found dispersed all over the tube, but are wholly confined to the bottom of the tube, the upper part being generally entirely free from colonies.

In the second place, it will be seen that the colonies are not by any means uniformly distributed over the bottom of the tube, but that they are more or less crowded together towards the front end of the tube, whilst the latter half is generally almost entirely free from colonies altogether.

As regards the nature of the colonies, they are, as in the case of those on the gelatine dishes already referred to, pure cultivations often possessed of characteristic appearances, sufficiently characteristic, at any rate, to enable the observer at once to discriminate between mould colonies, and colonies of other micro-organisms.

A little closer attention to the contents of the tube generally shows a very remarkable arrangement of the mould colonies as distinguished from the bacterial colonies, for the mould colonies will be found, on the whole, further from the front end of the tube than the bacterial colonies, the extreme colony being almost invariably a mould, often very considerably further down the tube than the last bacterial colony.

Thus the examination of air by Hesse's method brings to light certain very important facts concerning the aërial micro-organisms; firstly, their rapid gravitation in comparatively still air, and secondly, the more rapid gravitation of the bacterial organisms than of the mould organisms.

As a means of determining the number of micro-organisms in air, Hesse's apparatus is far more convenient than the method of Miquel and Freudenreich, which I have already described; it is, moreover, free from the objections which I have pointed out in connection with Miquel's process. On this account I availed myself of Hesse's method in making experiments on the distribution of micro-organisms in air.

To some of the results of these experiments I would now draw your attention. In studying the distribution of micro-organisms in air, I selected, as both a suitable and convenient spot for my central observatory, the roof of the Science Schools, at South Kensington. This position is well fitted for observations of this kind, being sixty to seventy feet above the ground, and thus removed from local and accidental influences. A number of experiments were made here with the view of ascertaining the influence of season and atmospheric conditions generally on the abundance of aërial micro-organisms. These experiments, which were extended over the whole of the past year, are summarised in the following Table and the diagram on page 490:—

Roof of Science Schools (South Kensington).

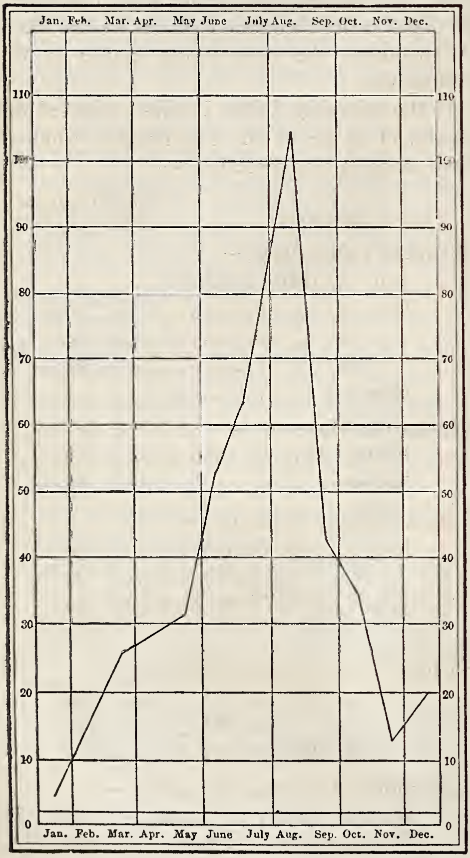
1886.	Average number of colonies obtained from 10 litres of air (Hesse's method).
January	4
March	26
May	31
June	54
July	63
August	105
September	43
October	35
November	13
December	20

Experiments on the Distribution of Micro-organisms at different Altitudes.

I have also made experiments with the view of ascertaining the relative abundance of micro-organisms at different altitudes in towns. These comparisons were effected by collecting samples of air at different elevations, on the spire of Norwich Cathedral, on the dome of St. Paul's, in London, and on Primrose-hill. The results of these experiments are exhibited in the accompanying diagram:—

Place of Experiment.	No. of Organisms found in 10 litres of air.
Primrose-hill, May 19, 1886.	
Top	9
Bottom	24

Place of Experiment.	No. of Organisms found in 10 litres of air.
Norwich Cathedral Spire, April 26, 1886.	
Top (300 ft.)	7
Tower (180 ft.)	9
Bottom (ground)	18
St. Paul's Cathedral, May 26, 1886.	
Golden Gallery	11
Stone	34
Churchyard	70



CURVE SHOWING THE AVERAGE NUMBER OF MICRO-ORGANISMS IN TEN LITRES OF AIR.

EXPERIMENTS ON THE DISTRIBUTION OF MICRO-ORGANISMS IN COUNTRY PLACES.

In a number of experiments made in the country, principally at Reigate and in Norwich, a very appreciably smaller number of micro-organisms was observed than in the case of the air in London. Moreover, the more remote the place is from human habitations, and from the frequented thoroughfares of traffic, the dust of which is always rich in refuse organic matters, the freer does the air become from suspended microbes. Thus, I found the air of an extensive heath near Norwich, and that of the Chalk Downs, in Surrey, exceedingly free from micro-organisms, whilst the air of gardens contained considerably more. Thus:—

Place of Experiment.	No. of Organisms found in 10 litres of air.
Reigate-hill, Feb. 7th, 1886	2
,, May 23rd, 1886	13
Heath near Norwich, April 23rd, 1886	7
,, ,, April 27th, 1886	5
Garden at Reigate, May 23rd, 1886	25
Garden near Norwich, April 28th, 1886	31

EXPERIMENTS ON THE DISTRIBUTION OF MICRO-ORGANISMS IN OPEN PLACES IN LONDON.

It is particularly interesting to compare the number of micro-organisms found in country air with that found in the air of parks within London. For this purpose I have made some experiments in Hyde-park, in Kensington-gardens, and on Primrose-hill. These experiments show that, although the park air generally contains fewer micro-organisms than the air even on the roof of the Science Schools, and consequently much less than in the streets below, yet the number exceeds that in the country air. The experiments in the parks were made on large surfaces of grass, from which practically no dust could be blown about, so that the microbes found are doubtless those which have been carried by the wind from the surrounding thoroughfares.

Place of Experiment.	No. of Organisms found in 10 litres of air.
Kensington-gardens, April 1st, 1886	13
Hyde-park, May 18th, 1886	43
,, June 7th, 1886	18
Roof of Science Schools, June 7th, 1886	62
Exhibition-road, June 7th, 1886	94
,, ,, June 8th, 1886	554
,, ,, ,, ,,	309
,, ,, June 10th, 1886	18

MICRO-ORGANISMS IN SEA-AIR.

In striking contrast to the number of micro-organisms found in the various places referred to above, is the number found in air at sea. I have not myself had an opportunity of making any experiments at sea, but recently some examinations of sea-air have been made by Dr. Fischer, a surgeon in the German navy, and as he has used substantially the same methods as those which I have described, his

results may be fairly regarded as comparative. Dr. Fischer's experiments may be thus summarised:—

I.—14 experiments with an average of 113 litres of air contained no organisms.

II.—5 experiments with an average of 80 litres of air contained 1 organism.

III.—2 experiments with an average of 110 litres of air contained 2 organisms.

IV.—3 experiments with an average of 146 litres of air contained 3 organisms.

V.—6 experiments with an average of 62 litres of air contained 4-13 organisms.

They may be more instructively classified, however, by taking into consideration the distance from the nearest land at the time of the observations, thus:—

Maximum distance from land in sea-miles, 90; 1 organism to 26 litres.

Minimum distance from land in sea-miles, 120; 1 organism to 93 litres.

Moreover, out of 12 experiments, made at a minimum distance of 120 sea-miles from land, in 11 the air was absolutely germ-free, and in the remaining 1 only a single organism was found; whilst out of 12 experiments made at a maximum distance of 90 sea-miles from land, in 7 cases organisms were demonstrable, and in only 5 cases not demonstrable. In 3 of these latter 5 cases, however, although the land actually nearest the ship was less than 90 miles, the nearest land in the direction from which the wind was coming was in two cases upwards of 500 miles, and in one case 200 miles. In the other two the land was, in one case, 60 miles, and in one case only 8 miles distant, but in this case the land in question was only a small, slightly cultivated, and thinly populated island.

This clearly demonstrates, what we should have been led from *à priori* considerations to anticipate, that the principal factor is the distance from land in the direction from which the wind is proceeding. It would further appear that the maximum distance to which, under ordinary circumstances, micro-organisms can be transported across the sea lies between 70 and 120 sea-miles, and that beyond this distance they are almost invariably absent.

Of particular interest in these experiments is the very distinct manner in which they show that the micro-organisms which are abundantly present in sea water are not communicated to the air, excepting in the closest proximity to the surface, even when the ocean is much disturbed.

Micro-organisms in the Air of Buildings.

It is obviously of interest also to ascertain whether the air which we breathe in our houses, and in enclosed spaces generally, is more or less charged with organic life than that which we meet with in the open. As the greater part of our life, in this country at any rate, is spent within doors—in dwelling-houses, in assembly rooms, in offices, in laboratories, in railway carriages, and the like—it is only natural that we should be particularly inquisitive as to where, and under what conditions in these various confined places we are likely to encounter the most living matter in the atmosphere.

In the following Table I have collected the results of some of the experiments which I have made in this direction:—

Place of Experiment.	No. of Organisms found in 10 litres of air.
Chemical Laboratory:—	
Jan. 13, 1886	13
Oct. 15, ,,	30
,, 16, ,,	14
,, 27, ,,	32
Nov. 12, ,,	8
Kensington Museum:—	
Friday, May 14, 1886	18
Saturday ,, 15, ,,	73
Natural History Museum:—	
May 21, 1886 (a.m.)	50
,, (p.m.)	70
June 14, 1886 (Whit Monday)	280
,, ,,	267
Burlington House (Royal Society):—	
June 9, 1886 (19·5° C.)	326
,, (22·0° C.)	432
,, 10, 1886 (17·0° C.)	130
Consumption Hospital, Brompton:—	
May 21, 1886	43
,,	130
,,	42
June 1, 1886	19
,,	34

Organisms Falling on a Given Horizontal Surface in Unit of Time.

In order to obtain an idea of the number of microbes which may, under favourable circumstances, become suspended in the air, I have made some experiments in places where I considered it probable that there would be a microbial population even denser than that in any of the previous cases to which I have re-

ferred. Owing, however, to my not having the necessary apparatus available at the time, I was only able to make rough tests as to the number of micro-organisms falling upon a given horizontal surface in a given time. As, however, I have made similar tests in the case of nearly all the experiments previously alluded to, I am able to make use of them by way of comparison.

Thus the number of micro-organisms falling on a horizontal square foot of surface in one minute was as follows in the case of some of the experiments which we have already discussed:—

Place.	Number of Micro-organisms falling on 1 sq. ft. in 1 minute.
Chemical Laboratory (4 experiments)	15
Kensington Museum (2 experiments)	54
Natural History Museum (2 experiments)	196
Natural History Museum, Whit Monday (2 experiments)	1,662
Burlington House (3 experiments)	222
Brompton Hospital (5 experiments)	54

We will now compare with the above the two cases to which I wish to draw your attention.

The first is that of a railway carriage (third class) on a journey from Norwich to London. Soon after leaving Norwich I tested the air; there were at the time four persons in the carriage, one window was closed, the other open, and the experiment was made near the open window. I found that under these conditions 395 organisms were falling on the square foot in one minute. On reaching Cambridge, the carriage was taken possession of by a number of men returning from Newmarket races. The carriage remained quite full (ten persons) to London. About half way between Cambridge and London I made a second experiment, one window being shut, and the other was only open four inches at the top, the air was tested near the closed window, with the result that no less than 3,120 organisms were found to be falling on the square foot in one minute.

On another occasion I made an experiment in a barn in which flail-thrashing was going on. The atmosphere was visibly laden with dust, and on testing it with a gelatine dish, I found that upwards of 8,000 organisms were falling on the square foot in one minute.

It would probably be difficult to find a place in which the number of suspended microbes was greater than this, the great abundance of bacterial life in the material under treatment, the dryness of the latter, and the violent commotion occasioned by the thrashing being all highly conducive to the distribution of an enormous multitude of micro-organisms throughout the air.

Later Improvements in Apparatus and Methods.

A lengthened experience with Hesse's method of determining the number of micro-organisms in air, convinced me that, although the method possesses many good qualities, it is by no means perfect, and that it has, in fact, many very serious defects, more especially when it is used in outdoor experiments. The fundamental defect in the process is that when the apparatus is used in a disturbed atmosphere, the results are liable to become seriously affected by aërial currents. Thus, if Hesse's tubes be exposed *without drawing any air through them*, a number of organisms gain access to the tube notwithstanding, and the number of these accessory organisms is dependent upon the strength and direction of the air-currents during the experiment.

In all my experiments with Hesse's apparatus, I have endeavoured to place the tube at an angle of 135° from the direction of the wind, so as to avoid a current of air entering the open end of the tube, but in several cases I have had to reject experiments in consequence of a sudden alteration in the direction of the wind, and in the open air there are almost invariably minor fluctuations.

In consequence of this, and several other defects, into which I need not here enter, I have devised a method in which I have endeavoured to overcome these objections. In this method, a definite volume of air is drawn, by means of an air-pump, through a short piece of glass tubing containing two small porous plugs placed one in front of the other. Of these two plugs, the first is constructed of glass wool only, whilst the second is formed of glass wool and glass or sugar powder. The object of this arrangement is that the second plug, through which the aspirated air has to pass, shall offer more resistance than the first, and, consequently, if the second plug is found to be free from microbes, it may safely be assumed that the first plug has been sufficiently obstructive to the micro-organisms in the air passing through, and that they have all been retained by it.

Each plug is then transferred, with special precautions, to a small flask containing a small quantity of sterile melted nutrient gelatine; with the latter the plug is now agitated, so as to cause the rapid disintegration of the plug, and the liquid gelatine, throughout which the *débris* of the plug and its contained microbia are distributed, is then evenly spread over the interior of the flask, and there congealed by rotating the flask in a stream of cold water. The flask is then maintained at a suitable temperature, and in due time the colonies, each resulting from one of the original micro-organisms deposited on the plug, make their appearance, and can be counted or further examined. That this process is, in contrast to Hesse's, practically independent of aërial currents, is seen from the fact that, if plugged tubes are simultaneously exposed without drawing air through them, the plugs are almost invariably free from organisms.

When air is simultaneously examined by Hesse's method and the "flask method" which I have just described, we find that indoors, and in an undisturbed atmosphere generally, the results are in very close accord, but that in a wind, more especially when the direction of the latter is variable, the results obtained by Hesse's method are considerably higher than those obtained with the flask method, the difference being obviously due to the defect which I have already pointed out in Hesse's method.

The practical identity of the results obtained under favourable circumstances by these two methods throws light upon the state of aggregation in which micro-organisms exist in the atmosphere. Thus, the colonies in Hesse's tubes are not necessarily each derived from a single microbe, but each colony might just as well be the result of a mass of organisms, which might be numbered by tens, hundreds, or even thousands. Each such aggregate, falling upon the surface of the gelatine in a Hesse's tube, would give rise to perfectly similar colonies. The colonies in the flasks, however, are obtained in a very different manner; here any masses of organisms would have become more or less broken up in the process of agitation to which the plugs are exposed in mixing with the gelatine. Consequently, if such masses existed, the number of colonies to which they would give rise in the flasks would exceed, and possibly to an enormous extent, those obtained in the Hesse's tubes; but, as we have seen, such is not the case, the number of colonies in the flasks being practically identical with those in the tube. It is thus evident that the aërial micro-organisms do not float about in aggregates, or masses, but as isolated individuals.

Experiments made with the flask method on the dome of St. Paul's tell the same story as those previously made with Hesse's method, and to which I have already referred. These experiments also illustrate the degree of accuracy which is attainable with the flask method.

St. Paul's Cathedral, November 19, 1886.

		Organisms found in 10 litres of air in each case by Flask Method.
Golden Gallery..	I.	10.
	II.	11.
	III.	11.
Stone Gallery ..	I.	35.
	II.	40.
Churchyard		47.

Nature of the Aerial Micro-organisms.

The organisms present in the atmosphere are of many different kinds—moulds, bacilli, micro-cocci, and various forms of yeast or saccharomyces. Of these several kinds of organisms, the moulds have received most attention at the hands of botanists, and, indeed, even the general public is only too familiar with the commoner forms, such as the *Penicillium glaucum*, which is so much at home in pots of preserved fruit, and which is a highly unwelcome guest in the larder. Indeed, some of these moulds appear to be the most widely distributed of all organisms, and are the most difficult to banish from the air. Thus, as a general rule, in those places where fewest organisms are found, *e.g.*, at high altitudes and in the open country, the relative proportion of moulds is much higher than in the air of towns and enclosed spaces. It is not difficult to account for this wide distribution of moulds in the atmosphere, when we call to mind their behaviour in Hesse's tubes; there, you will remember, the mould colonies were generally found penetrating further into the tubes than any of the bacterial colonies, clearly showing that their buoyancy in air is greater than that of the other organisms, and on this account also they are floated by aërial currents to altitudes and distances which are not reached by the other forms of organisms.

The different kinds of bacilli and micro-cocci occurring in the air are less generally known, and it is only now that their identifica-

tion and characterisation are beginning to attract much attention. A few forms giving rise to very striking appearances when growing on natural nutritive media, generally articles of food, have been long known, and have at times excited much curiosity. Perhaps the most notable of these forms is the so-called *M. prodigiosus*—really a bacillus, and not a micro-coccus—which gives rise to a superb blood-red colour, which you see here. This organism flourishes in milk, to which it imparts the same intense colour, which was formerly supposed to be due to disease in the cow. It also thrives well on bread, and has occasionally been known to make its appearance on the sacred wafer, where it has not unnaturally given rise to superstitious fear and consternation.

There are several other bacilli or micrococci frequently present in the air, which also produce striking pigments when cultivated on suitable materials. Examples of these I have here:—

M. candicans (very common).
Sarcina lutea.
,, *aurantiaca.*
M. rosaceus.
M. carnicolor.
B. aureus.
B. fluorescus.
B. auresceus siccus.
B. chlorinus (very common).

Another pigment-forming micro-organism which is frequently present in the air, is *Saccharomyces rosaceus.* Of the other bacilli, the hay bacillus, or *B. subtilis,* may be mentioned as of very frequent occurrence in the air.

As regards the functions of these various micro-organisms found in the atmosphere, very little indeed is at present known. That the various processes of spontaneous fermentation, decay, and putrefaction, which take place in suitable substances when these are exposed to the air, are due to micro-organisms gaining access from the air, is well established, but only in very few cases has it been shown that particular changes of this kind have been traced to the action of particular and well characterised organisms. Indeed, recent researches have shown that many of the most familiar changes of this kind, such as the conversion of urea into carbonate of ammonia, of ammonia into nitric and nitrous acids, of sugar into lactic and other acids,—are capable of taking place through the agency of totally different forms.

Of pathogenic forms, it may be stated that practically none have been demonstrated in the air, but this need not excite surprise, when it is remembered that in all cases in which pathogenic organisms may be expected to pass into the air, as in the drying up of diseased products of various kinds, these pathogenic forms will be accompanied by an enormous preponderance of non-pathogenic, or "saprophytic" forms, so that the actual discovery of the comparatively few pathogenic amongst the overwhelming number of saprophytic organisms becomes an almost hopeless matter. Amongst the aërial organisms, however, a few have been discovered which are pathogenic to some of the lower animals; thus, quite recently an aërial organism, of comparatively frequent occurrence, has been shown to be identical with a bacillus which was previously supposed by Emmerich to be the inducing cause of Asiatic cholera, and which was discovered by him in the tissues of cholera patients, during the Naples epidemic of two years ago.

Indeed, many of the organisms which have been found in air may be pathogenic to man, although they are not connected with any of the commoner zymotic diseases. In this case, however, it is impossible to make actual experiments in this direction. But it is with the object of excluding such possibly pathogenic forms in the air, that the stringent precautions in the antiseptic treatment of wounds are taken.

But although the organisms connected with the common zymotic diseases have not been discovered in air, yet there can be no doubt that, in the immediate vicinity of the foci of disease, such organisms are present, and that their distribution and conveyance in the air will take place in just the same manner as in the case of those organisms, the distribution and conveyance of which, through the atmosphere, we have been considering this evening. The investigations on the distribution of micro-organisms, by showing us what circumstances are favourable and which unfavourable to their dissemination, teach us how we may avoid distributive influences coming into play in the case of the organisms of infectious diseases. The scanty microbial population of country, of mountain, and more especially of sea air, which these investigations reveal, point to the security

from zymotic disease which these surroundings are well known to confer. On the other hand, we learn that in the air of towns, and still more conspicuously in the air of crowded apartments, we are invested with an atmosphere laden with living organisms, amongst which, therefore, the chance of inimical forms being present is greatly enhanced. We have seen, however, that in rooms and even in hospital wards the number of organisms is very small provided the air is undisturbed, and this points to the importance of preventing any aërial commotion during the exposure of wounds in surgical operations, and in places generally where pathogenic organisms may be expected. We learn, moreover, the great importance of removing all dust and refuse matter generally in a moist condition, and with the least possible delay, for the micro-organisms present in a moist substance can only be transferred to air in two ways, viz., firstly, through its desiccation and conversion into dust; and, secondly, through the formation of spray, especially through the generation of gas in the liquid medium—*e.g.*, in the putrefaction of sewage.

In conclusion, I should like to express my opinion that it is the chemical side of bacteriology which at the present moment imperatively demands attention, and which should no longer be suffered to remain in neglect.

In the most prominently attractive department of bacteriology—the pathological—a vast amount of material has already been collected, and, owing to the high degree of perfection to which the methods of studying micro-organisms have been brought by the investigators in this department, much of the difficulty which previously stood in the way of the investigation of the chemical phenomena of bacterial life is now removed.

DISCUSSION.

The CHAIRMAN said he had not the slightest intention of criticising the paper, or even of commending it, for he was quite sure that all who had heard it would agree that it had been no less admirable in treatment than as regarded the subject-matter; but he would just make a few remarks suggested by the closing paragraphs, having special regard to what might be called the human interest of the subject. After all, these micro-organisms were feared because they were suspected of being the causes of disease, and the question which was of real interest to all was that which had been referred to as the pathological question. There were two ways in which this subject had pathological relations, and they were both very full of importance. Two distinguished names, amongst several others, had been mentioned, that of Sir Joseph Lister and that of Dr. Koch, and they represented the two aspects of the subject to which he wished to draw attention. Mr. Lister's investigations were commenced a long time ago, very shortly after the great fundamental discovery of Pasteur, that the process of putrefaction could not take place without the presence of what were called septic organisms. That was about the year 1862, and what Lister discovered was the correlated fact that the pathological process of inflammation, with which was connected suppuration, and all those terrible consequences which occurred after wounds, and which gave to surgical operations and to wounds all their terrors, and to which the pain which followed surgical operations and wounds was mainly due, could not be produced unless these same organisms were present. That discovery was substantially completed by Lister himself, but it had now been established by a long series of observations made by other surgeons and pathologists, both in this country and in Germany. That was one of the relations. Quite distinct and separate from this there was another fact, viz., that certain particular organisms existed not only in the air we breathe, but in the water we drink, and in all the media which surround us, which were the specific causes of particular diseases. This notion theoretically existed long ago, but it was only lately that experimental proof of it had been obtained. Ten years ago he had made acquaintance with Dr. Koch, who was then a country practitioner in Silesia, and had just made a great discovery with reference to the poison which caused the cattle disease, now well known to everybody as anthrax, the most destructive of all diseases of cattle; that it was possible to separate it from the diseased parts of the animal affected in the form of a plant; and had shown that it was possible to cultivate this plant, to sow it on a soil suitable to its growth, separate from the living organism in which it had previously existed and grown, and that he could keep it alive away from its source for a length of time; and, finally, that however long it had been kept, it could be proved to be still the same poison that it was before. He had shown the identity of the poison—of the material cause of the disease—with the growing organism. Since that time, by the methods which Dr. Frankland had described, which was first introduced by Dr. Koch, other pathologists had succeeded in doing the same thing, but only for a very few diseases, perhaps four, perhaps five. Happily, amongst those diseases were two of the most destructive to which man was liable—the most destructive certainly of *chronic* diseases, viz., tuberculosis; and now by a discovery which was not perhaps quite mature, but was all but mature—a discovery which we owed to the masterly

skill and ingenuity of one of the inspectors of the Local Government Board, Mr. Power, and to the extraordinary skill and perseverance of Dr. Klein—they were now probably in a position to say as much for scarlatina, the most destructive of all the *acute* diseases to which the population of this country were exposed, as could previously be said as to anthrax or tuberculosis. These were the facts bearing upon the pathological relation of this subject, which Dr. Frankland had investigated with such extraordinary exactitude, and it was for this reason that so much interest attached to these researches. As the reader of the paper had said, the living dust of the air was not a thing to be feared, but considering that they knew it contained organisms which were capable of producing putrefaction, and consequently inflammation in wounds—for that was a thing about which they were certain—and it might contain the distinctive or specific poisons of particular diseases, therefore, just as when rabies was prevalent amongst dogs all dogs should be taken care of, or as in countries where there were poisonous snakes care was taken to keep all snakes out of houses, so it behoved everyone to be as careful as possible to maintain the air as free as possible from these minute organisms, not because they were all dangerous, but because they did not know where the danger lurked. And hence the importance of acquiring a complete scientific knowledge of everything relating to their natural history. It was only by the possession of this scientific knowledge that they could hope to become masters of the conditions which influenced the development and growth, the origin and existence in the air and water and other media, of these more dangerous organisms on which disease was directly dependent. A number of interesting questions were suggested by the paper relating to the immediate subject, viz., the determination of the number of organisms which existed in the air and water, and there were many points which unquestionably would be most usefully illustrated by discussion. It had been suggested to him that, considering the importance of the subject, it might be convenient to adjourn the discussion.

Dr. Alfred Carpenter said there were so many questions raised which were of interest to all those who, like himself, were engaged in combating disease, that he should be very glad if the discussion could be adjourned to a future evening. It was very gratifying to have this solid foundation to start with which was now before them, which, by analogy, might be worked on advantageously in further directions.

The Chairman said if Dr. Carpenter would kindly undertake to open the adjourned discussion, it would very likely be of benefit to the Society, and he would therefore adjourn the meeting until the following Wednesday evening.

APPLIED ART SECTION.

Mr. Hubert Herkomer, A.R.A., invited the Committee of the Applied Art Section (of which he is a member) to visit him at his house at Bushey, on Friday afternoon last, 18th inst., and the following gentleman accepted the invitation:—Mr. T. Armstrong, Lord Alfred S. Churchill, Mr. Francis Cobb, Mr. Walter Crane, Mr. Lewis F. Day, Colonel Donnelly, C.B., Mr. Hunter Donaldson, Mr. Buxton Morrish, Mr. J. Hungerford Pollen, Mr. W. H. Preece, F.R.S., Sir Robert Rawlinson, C.B., Mr. Owen Roberts, Mr. E. C. Robins, Mr. W. Simpson, and Mr. J. Sparkes, with Mr. H. Trueman Wood, Secretary of the Society, and Mr. H. B. Wheatley, Secretary of the Section.

Mr. Herkomer received the party in his studio, where were gathered several of the artistic objects which will subsequently find their several places in the various rooms of the new house which is projected. Mr. Herkomer explained the principles which guided him in the work carried on in his house, which was the outcome of the individuality of three generations of his family, and he then led the party through the various rooms, showing the processes at work by which all the materials for his new house are prepared on the spot, and the party completed the survey by a visit to the school which is situated in a building of wood, the materials for which were entirely prepared in the workshops at Bushey.

The Art School, of which Mr. Herkomer is president, was founded four or five years ago by Mr. Eccleston Gibb and Mr. Herkomer, the former supplying the necessary funds, and the latter undertaking to give his services as president and teacher. There are now about sixty students, as many as the school can accommodate. The students receive instruction only in drawing and painting, not in any of the other branches of art which Mr. Herkomer is carrying on for the purposes of the house which he is building. The fees are £6 6s. a term, there being three terms in the year. The students find lodgings for themselves in the village of Bushey. Candidates for admission are expected to pass a qualifying examination. There is an elementary class, and a life class for men and women.

The idea predominant in the arrangement and construction of Mr. Herkomer's house is that the planning is independent of the elevation, which is to adapt itself to the

interior, and not the reverse, as is usually the case. With regard to the wood-carving, it is Mr. Herkomer's wish to obtain that individuality of treatment in the carrying out of a given design which is seen when various competent carvers are employed on the work. The principle that large objects should not be carved in too minute a manner is exemplified in a mantelpiece of gigantic proportions, arranged to contain seats in the chimney corner. This is carved in a bold style, in which is struck a loud note, which, in the carved panels of the room, is played in a more subdued key.

Besides the wood-carving much wrought iron work was seen. From the front of the mantelpiece, mentioned above, spiings a fine bracket, square in outline, but flowing in subordinate treatment, from which hangs an iron lamp, to which electric lamps will eventually be attached. A fine specimen of copper scroll worked from extremely thick metal was also seen.

Miscellaneous.

TREATMENT OF SILVER ORES IN MEXICO.

Consul Winslow, of Guerrero, says that in the neighbourhood of all the mines in Mexico there are *haciendas de beneficio*, or works for extracting the silver from the ore. These buildings are generally about 300 feet long, and at the back there is a courtyard. In front there is generally a large doorway for entrance, where nobody is allowed to enter without previous permission. The *hacienda* is managed by an administrator, who has his officials and clerks, and directs the establishment. The peons, or workmen, gain from three shillings to four shillings a day, and are paid off at the end of each week. The ore as it is brought from the mine is in large pieces, and these are piled up in the courtyard in a huge pile. They are in the first place put into an enclosed box, and pounded to pieces by immense wooden pounders, armed at the end with iron pestles, which are lifted up by arms connected with an axle, which is turned by mules. The end of these arms fit into a notch in the pestles, and lift them up a certain distance, and then the end of the arm slips out of the notch, and the iron pestle falls down with an immense force upon the mineral, and crushes it into small pieces. These fall down upon a sieve made of hide, and the smaller pieces fall down through the holes in the sieve, and the larger pieces are thrown back under the pestles to be again crushed. There are several of these pestles in a straight line, connected with the same axle, and they are lifted up alternately. After the ore is pounded to pieces in the mortars, it passes to the mills, which consist of a round vat placed on a level with the floor, where the metal is ground up into a fine mud, water being added, by means of three heavy and hard granite stones, of an oblong shape, which are tied to the arms, connected with a revolving axle turned by a mule, which walks round in a circle blindfolded. Into holes made in the stones sticks are introduced, and these are connected by means of ropes or chains to the revolving arms. There are several of these circular vats all situated in a line in a long room, each worked by a mule, blindfolded. These are called *tahones*, and the crest pole in the middle the *peon*, with two arms of wood, from which are suspended the heavy stones, called *metapiles* or crushers. From here the ore, which has the appearance of mud, is thrown out into the courtyard, which has a floor well made of hard cement or stone, and here are added quicksilver and salt in a liquid state, or *caldo* as it is called. It is thus left in the open air, exposed to the heat of the sun, some twenty or thirty days, and is stirred up every day or two by the feet of men and horses, who walk round in a circle until the quicksilver and the salt are well incorporated with the ore. When this process is completed, the mud thus washed is called *torta de lama*. After the ore is thus worked or brought to a proper state, it goes to the *lavadero*, or washing-place, which is a round vat made of wood and stone, where the silver is separated from the earth, and here is where the *tortas de lama* are taken from the yard, and here remains, after the mud is washed out, what is called the *plata pina*, or amalgamated silver. This amalgam is then put into stout canvas bags, and submitted to a heavy pressure to get rid of the mercury, and afterwards it goes to the furnace, where the silver is purified of all foreign substances. There is an additional process which is pursued with certain kinds of ores. After the mineral has been exposed to the sun in the *patio*, or courtyard, it is transferred to the *planillo*, which is an inclined plane in the open air, having a solid stone floor about sixty feet long and twenty feet wide. At the foot of this sit a number of nearly naked men, who are engaged in throwing water gradually on the mass of mud by means of pieces of ox horn, so that the mud flows off, and runs outside the yard into a ditch, and the silver, with some mud, is left at the foot of the inclined plane. After this process, the greater part of the mud has been removed, and only a small portion remains which contains the silver. This mud is then taken to a room on the second floor, where it is placed in the *criso*, a large round iron boiler, with fire underneath; water is added, and it is stirred up by means of revolving arms worked by a mule, and the remaining mud flows off, only a small portion remaining. The rest of the process consists in removing the remain-

ing substance to the amalgamating room, where quicksilver is added, which unites with the silver in the mud, and this is further washed, and only the quicksilver is left united with the silver. This is further purified in the furnace, and the silver runs off into moulds, and is then sent to the mint at San Luis Potosi to be coined. There are different kinds of ores—one which is merely exposed to the fire of a furnace, and this is called *fundicion*, and another of the *patio* or yard. One kind of ore goes to the *patio*, and from there to the *lavadero*, and another goes to the *planillo*, and from there to the *criso*. The white and green silvers are put through the process of the *patio* and the *criso*, the bronzes and those containing lead, and those mixed with other minerals, are extracted by the *patio* and the furnace. The processes used for extracting the silver are very primitive. From three hundred pounds of crude metal only three to eight ounces are extracted. Some of the richer ores, after being ground up, are mixed as before with mercury and salt, and then made into *tortas* or piles, some six feet in diameter, and an Indian, bare-legged, commences in the middle and walks round regularly, placing one foot before the other by a peculiar movement, and leaves not a single particle unstamped, and this is kept up all day, the object being to unite the crude mercury with the silver. These men are paid at the rate of about one shilling and sixpence a-day. There are three different kinds of silver ore extracted from the mines, according to the description of the metal with which they are combined, although there are other varieties. There is the *plata blanca*, or white silver, which is the purest and rarest. In this variety the silver can be seen resting on the surface of the stone. There is also the *plata verde*, or green silver, and in this variety the silver is united with copper, and the veins of blue and green in the ore are the silver with the copper. *Las bronces* contain silver, but in a less quantity, united with iron which looks like brass or gold. *Plomosas*, where the silver is united with lead, is frequently met with at the mines situated in Nuevo Leon, such as Ballecilla, Cerralvo, and Villaldama. All the different kinds of silver are called *azogues*, or quicksilvers, and there are also *caliches*, or chalks, which are rich in silver and very common in places.

Correspondence.

PURITY OF BEER.

I regret that indisposition has prevented me from replying sooner to Dr. Bernays' letter upon the above subject. In my paper, read before your Society, I made a statement to the effect that if Dr. Bernays was of opinion that noxious ingredients were used by the brewer in the preparation of beer, then his position as a public analyst demanded that he should have reported these facts to Somerset-house. As the result of inquiry, I find that this was not done; he was, it is true, in the year 1878, concerned in a prosecution which charged a publican, who bought his beer from Messrs. Meux and Co., with having adulterated the beer with salt, but the prosecution broke down, and was withdrawn, and since that time Dr. Bernays has been content with the expression of his opinion upon the subject; and it must be admitted that his views are totally at variance with those of specialists who have devoted years of study to the subject.

Dr. Bernays states that this is a very incorrect representation of the case, and further on in his letter he accuses me of having put a gloss upon it which it would not fairly bear. Now, if I have done this, I shall be only too willing to express my regret, but I think I am able to adduce proof that my statement, as made before your Society, was not only substantially correct, but was absolutely warranted by the facts of the case.

I have brought the letter of Dr. Bernays, published in your *Journal*, before the notice of Messrs. Hunter and Haynes, who were the solicitors for the defence in the case referred to. They have written me a letter, for which I must ask your insertion, inasmuch as it involves a matter of importance to me, and to the firm whose name I took the liberty of mentioning. The letter is as follows:—

9, New-square, Lincoln's-inn, W.C.,
9th March, 1887.

SIR,—As you have called our attention to Dr. Bernays' letter to the *Journal of the Society of Arts*, issued on the 25th February, and especially to the paragraph therein, purporting, we presume, to be an extract from some public journal, giving an account of a Government prosecution against one Ayres for adulteration of beer, we have referred to the shorthand notes taken at the adjourned hearing of that case, a copy of which appeared in the *Morning Advertiser* of the 16th February, 1878. To this report we beg to refer you, as it is too lengthy to quote *in extenso*, but we ought perhaps to give in this letter the concluding remarks of the magistrate and the solicitors for the prosecution, which were as follows:—

Magistrate.—Then it appears to me there is nothing remaining but for you to withdraw the summons. I am sitting here to decide an important prosecution, and I beg leave to say that the defendant is entirely exculpated from blame, and not only he, but the gentlemen who supplied him. There is not a shadow of pretence for saying that the law has been broken in any way.

Mr. Simpson.—Of course neither the Board nor the analyst are to blame. When we find a great excess of salt, it is impossible for us to know whether it has been added or whether it is a natural product of the ingredients used in the brewing. In the beers sent out by some firms of brewers there is so much less salt than in that of others that it is impossible

to tell whether salt has been added or not if we find it in excess. It is agreed then that the summons be withdrawn.

Magistrate.—The summons is withdrawn.

This shows an entirely different result to that suggested by the extract in Dr. Bernays' letter, and we may fairly leave you to say whether, after reading the verbatim report of the case, you consider any portion of the proceedings justified the construction put upon them by Dr. Bernays.

We are, Sir,
Yours, obediently,
(Signed) HUNTER AND HAYNES.

I think it will be agreed that further comment upon this portion of Dr. Bernays' argument becomes unnecessary, in view of the above-quoted letter.

Dr. Bernays states that it was not his duty to report the cases to Somerset-house, as the Act requires nothing of the kind. Dr. Bernays has somewhat misunderstood me in concluding that I thought the Act did require him to report such cases. What I do contend is, that the position of Public Analyst involves a social as well as a legal responsibility, and if Dr. Bernays is clearly of opinion that brewers use ingredients which are noxious to health, and further, if he is in a position to expose the employment of such injurious materials, then I state—and I see no cause to alter my opinion—that it is morally obligatory upon him to expose such transgressions. He has not done so, and I venture to assert that he was not in a position to have done so, for the very sufficient reason that no injurious ingredients are employed.

I have challenged Mr. Quilter to prove the employment of injurious ingredients in the preparation of beer, and that challenge has not been accepted. I venture to extend it to Dr. Bernays, and I shall be glad if he will bring before the notice of the public any one ingredient used at the present day, in any brewery in England, in such quantity, or of such quality, as could by any impartial person be termed noxious to the human system. If Dr. Bernays cannot meet this challenge, then I do not think it is quite fair of him to institute negative charges, and I am sure, upon reflection, he would be the first to withdraw them.

Dr. Bernays has further stated that the alcohol prepared from malt substitutes is more injurious than that prepared from malt. In discussing my paper *he adheres to his view*. In meeting this somewhat peculiar method of argument, I would invite Dr. Bernays to prepare alcohol from those various substances, to separate the alcohol from the water, &c., as I have done, and let him make a comparative examination of the two samples for injurious alcohols; he will find that the all-malt alcohol will contain far more injurious homologues of ethylic alcohol than that obtained from the substitutes. In proof of these assertions, I would refer Dr. Bernays to the manufacture of alcohol as ordinarily carried on in this country; he will not fail to find that it is only the intermediate portions of the distillate that are available in the preparation of spirits; the first and last runnings being neglected for dietetic purposes, owing to the large amount of noxious ingredients in these two fractions. If brewing sugar be employed, it is well known that no such fractions are obtained, and that the alcohol is almost absolutely pure.

I take this opportunity of correcting some small errors which have crept into my paper:—On page 255, col. 2, line 21, for 53s. 3d. read 35s. 3d.; on page 262, col. 2, line 20, for 40 lbs. per bushel read 50 lbs per bushel; on line 23, same page, for 24,107,857 cwts. read 30,134,821 cwts.; and on line 25, same page, for 40 per cent. read 50 per cent.

ALFRED GORDON SALAMON.

The Laboratory, 1, Fenchurch-avenue. E.C.

THE APPLICATION OF GEMS TO THE ART OF THE GOLDSMITH.

In Mr. A. Phillips's paper on "The Application of Gems to the Art of the Goldsmith," in last week's *Journal*, there is one serious mistake. The "Orloff" diamond is mentioned as weighing 779 carats, whereas the proper weight should be stated as 193 carats. Orloff paid the merchant from whom he obtained this gem the sum of £90,000 in cash, besides giving him an annuity of £1,000 a year. It may interest you to know that the true name of the "Orloff" stone is said to be "Koh-i-Tûr," or "Sinai."

EDWIN W. STREETER.

Notes on Books.

TEXT-BOOKS OF SCIENCE.—THE STEAM-ENGINE. By G. C. V. Holmes. London: Longmans, 1887.

Mr. Holmes's object in preparing this the latest of Messrs. Longmans's Text-books of Science, has been to produce a volume intelligible to all students possessed of moderate mathematical knowledge, which shall yet present an adequate view of those branches of science by the aid of which the modern steam-engine has been brought to its present state of perfection. Avoiding any historical treatment of the subject, the author begins with a description of the elementary steam-engine; then follows a chapter on heat, its measurement, and its effects on fluids. The theoretically perfect heat-engine is next described, and compared with the best actual steam-engines. The theoretical conditions governing the actual construction of engines leads up to a chapter on the mechanics of the steam-engine, followed by others on its mechanism and details. Valves and valve gears

have a chapter to themselves, as have also indicators and indicator diagrams. The boiler next comes under consideration, with the whole question of the combustion and utilisation of fuel, leading to the description of condensers and condensation. Loss of efficiency and methods for reducing it are dealt with in the last chapter, and here we find included jacketing, superheating, and compounding.

The points on which the author himself lays most stress, as those on which he has endeavoured to give information in a form suitable for beginners are—(1) the modern science of thermo-dynamics; (2) the effects of inertia in quick-running engines; (3) geometrical methods of fixing dimensions and sitting of slide valves; (4) the methods of diminishing loss of efficiency, superheating, jacketing, compounding, &c.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 30.—Adjourned discussion on DR. PERCY FRANKLAND'S paper on "Some of the Conditions Affecting the Distribution of Micro-organisms in the Atmosphere." PROF. J. BURDON SANDERSON, M.A., M.D., LL.D., F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MARCH 29.—"Colonial Wines." By RICHARD BANNISTER. R. BRUDENELL CARTER, F.R.C.S., will preside.

CANTOR LECTURES.

The Fourth Course will be on "Machines for Testing Materials, especially Iron and Steel." By Prof. W. C. UNWIN, F.R.S. Three Lectures.

LECTURE II.—MARCH 28.—Maillard and Emery machines.—Large machines without levers.—The Union Bridge Company's machine.—Methods of holding specimens.—Forms of specimens.—Measuring apparatus.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. C. Unwin, "Machines for Testing Materials, especially Iron and Steel." (Lecture II.)

Royal Institution, Albemarle-street, W., 3 p.m.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. J. T. Wills, "Between the Nile and the Congo; Dr. Junker and the (Welle) Makua."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. H. Crossland, "The Holloway Sanatorium and the Royal Holloway College."

Actuaries, The Quadrangle, King's College, W.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, MARCH 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Richard Bannister, "Colonial Wines."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. Gamgee, "The Function of Respiration." (Lecture XI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on Colonel E. Maitland's paper, "The Treatment of Gun-Steel."

WEDNESDAY, MARCH 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Adjourned discussion on Dr. Percy Frankland's paper, "Some of the Conditions affecting the Distribution of Micro-organisms in the Atmosphere."

Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 o'clock. (Annual Meeting.) President's address. Reading of papers and discussion.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Mr. Allen P. Jones, "Trade-Mark Practice, with Notes on the Act of 1883." 2. Mr. Abel's "Notes on the Proceedings of the Commission on the Working of the German Patent-law."

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. Nelson Boyd, "Notes on the Panama Canal."

Chemical, Burlington-house, W., 8 p.m. Anniversity Meeting. President's Address.

THURSDAY, MARCH 31...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), 12 o'clock, Morning Meeting; 7 p.m., Evening Meeting Reading of papers and discussion continued.

Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof Huxley, "The Gentians; Notes and Queries." 2. Prof. E. Selenka, "Gephyreans of Mergui Archipelago." 3. Mr. C. B. Plowright, "British Heteræcious Uredines."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. James Orrock, "The English Water Colour School" (with Remarks on the late Controversy of Light and Water Colours, illustrated by "Proofs" before and after Letters).

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. Max Müller, "The Science of Thought." (Lecture III)

FRIDAY, APRIL 1...Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS). 12 o'clock, Morning meeting. 7 p.m., Evening meeting. Reading of papers and discussions continued and concluded.

United Service Institute, Whitehall-yard, 3 p.m. Capt. John F. Ross, "Belligerent Rights, and what is lawful in War."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Dewar, "Light as an Analytic Agent."

Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. E. W. Moir, "Hydraulic Appliances at the Forth Bridge Works."

Geologists' Association, Univerity College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Prof. Postgate, "Greek and Latin Etymologies."

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, APRIL 2...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Sound." (Lecture VI.)

CORRECTION.—Page 471, col. 1, line 4, *for* London and North-Western *read* Lancashire and Yorkshire.

Journal of the Society of Arts.

No. 1,793. Vol. XXXV.

FRIDAY, APRIL 1, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COLONIAL AND INDIAN EXHIBITION REPORTS.

The Reports on the Colonial Sections of the Exhibition, prepared under the direction of the Council of the Society, at the request of H.R.H. the Prince of Wales, Executive President of the Exhibition, and President of the Society, are now ready. The following is a list of the reports:—

1. Mining Industries. By C. Le Neve Foster.
2. Minerals and Gems. By J. Reynolds Gregory.
3. Meat and Dairy Products. By Clare Sewell Read.
4. Grain. By W. Proctor Baker.
5. Fruits. By D. Morris.
6. Tea. By A. G. Stanton.
7. Coffee. By H. Pasteur.
8. Cocoa. By H. Pasteur.
9. Sugar. By Neville Lubbock.
10. Wines, Spirits, Beer, and other Fermented Liquors. By R. Bannister.
11. Tobacco. By G. Watt and John McCarthy.
12. Drugs, Chemical and Pharmaceutical Products. By B. H. Paul.
13. Oils and Fats. By Leopold Field.
14. Gums, Resins, and Analogous Substances. By Thomas Bolas.
15. Cotton. By J. Butterworth.
16. Wools. By F. H. Bowman.
17. Silk. By T. Wardle.
18. Miscellaneous Fibres. By C. F. Cross.
19. Leather, Leather Goods, Furs, Hides, and Tanning Materials. By J. Powell.
20. Timber (No. I). By T. Laslett.
21. Timber (No. II.). By Allen Ransome.
22. Machinery. By W. Anderson.
23. Musical Instruments. By John Stainer.

The volume (demy 8vo, 505 pages) is published by Messrs. Clowes and Sons, price 10s. 6d. Members of the Society can obtain copies at the reduced price of 8s., by applying to the Secretary.

CANTOR LECTURES.

Professor W. C. Unwin, F.R.S., delivered the second of his course of Cantor Lectures on "Machines for Testing Materials, especially Iron and Steel," on Monday evening, 28th inst.

The lectures will be printed in the *Journal* during the summer recess.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. Barrett, Mus.Bac., Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing Monday, 23rd May, 1887.

Full particulars can be obtained on application to the Secretary.

INDIAN SECTION.

Friday, March 25; Major-Gen. J. Michael, C.S.I., in the chair.

The paper read was "Indian Coffee: its present production and future prospects," by Frederick Clifford.

The report of the meeting will appear in next week's number of the *Journal.*

FOREIGN & COLONIAL SECTION.

Tuesday, March 29; R. Brudenell Carter, F.R.C.S., Member of Council, in the chair.

The paper read was on "Colonial Wines," by Richard Bannister.

The report of the meeting will be given in the number of the *Journal* for April 15.

Proceedings of the Society.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 30th, 1887; Henry Power, F.R.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bewley, Thomas Arthur, Port of Dublin Ship-yard, Dublin.
Hill, Henry, The Brewery, Southwark-bridge-road, S.E.
Humphries, John, 695, Holloway-road, N.
King, William David, Lynwood, Waverley-road, Southsea, Hants.
Power, Henry, F.R.C.S., 37A, Great Cumberland-place, W.
Rosher, Charles Henry, 22, Charing-cross, S.W.

The following candidates were balloted for and duly elected members of the Society.

Cornell, William, Rydal-road, Streatham, S.W.
Game, Tom, 36, Acton-st., Gray's-inn-road, W.C.
Huggins, J. Frederick, Lion Brewhouse, Broad-street, Golden-square, W.
Joy, Albert Bruce, The Studio, Beaumont-road, West Kensington, S.W.
Merrill, Edwin John, Thornhill, Wallwood-road, Leytonstone, E.
Mure, Arthur Henry, 2, Marloes-rd., Kensington, W.
Ritchie, Alexander, 4, Upper Thames-street, E.C.
Titmas, William, 32, Grafton-street East, Tottenham-court-road, W.C.
Watt, Thomas Rossiter, The Briars, Chislehurst, Kent.

AND AS HONORARY CORRESPONDING MEMBERS:—

Ferguson, Alastair Mackenzie, C.M.G., Colombo, Ceylon.
Ferguson, John, Colombo, Ceylon.

The Adjourned Discussion on Dr. PERCY FRANKLAND'S paper on "Some of the Conditions affecting the Distribution of Micro-organisms in the Atmosphere," was resumed.

Dr. ALFRED CARPENTER said he had moved the adjournment of the discussion last Wednesday, because it appeared to him that there were parts of the paper which were worthy of full consideration. There were two or three points which commended themselves to his judgment as a very substantial proof of the knowledge which a few years ago was thought to be very visionary, but which was now proved to rest on a very substantial foundation. There were points also to which he should perhaps take some exception. Those points were not the substantial facts which were detailed in the paper, but were some of the opinions of the learned author of the paper when he commenced his address. Then, again, there were the views in the conclusion of the paper, with which he (Dr. Carpenter) was specially interested, having for a number of years paid a considerable amount of attention to the causes of disease as promoted by micro-organisms. The first part of the paper he took exception to was where these micro-organisms were spoken of as if their presence and action were a blessing. Dr. Frankland also spoke of the great advantages, and comforts, and the pleasure which belonged to those that produced alcohol; and, as a consistent abstainer, he (Dr. Carpenter) did not agree with the conclusions which the author's paper had come to, as he had an impression and opinion that the world would have been far happier if these micro-organisms had never had an existence. The proof that they had to do with fermentation, and that all the alcohol produced was the production of some form of micro-organisms, was undoubted. This was shown very clearly by the facts that had been detailed by Pasteur, and especially by others who had been working in this particular field for a long number of years. It was evident that these micro-organisms had a very important influence in promoting the production of that which he considered to be a very great evil. It was true that the organisms existed everywhere, and that their action in producing alcohol did undoubtedly exist without the intervention of man; but in the majority of instances it was by the intervention of man that certain forms, at any rate, had been brought into use, and strong drink, which was the result of man's action, and not of the action of nature, was one of those which he wished had no existence at all. They had to face the fact that it had an existence, that it had an influence, and to endeavour as far as possible to mitigate the incidence of that evil influence, and try to stop the progress of it as far as possible. The Chairman of the last meeting (Dr. Burdon Sanderson), in his concluding remarks, made an observation which he (Dr. Carpenter) could not endorse, but which had a bearing upon this very subject. He said that, because a certain number of dogs had become rabid, it was right to lock up all dogs, so as to prevent the evils which might arise from the spread of hydrophobia. To carry out that principle to its logical end, it was evident that, if we wished to get rid of the action of the microbes in alcohol, it would be necessary to lock up the alcohol, and that was a proceeding approved of by a considerable number. There the things were, and one had to deal with them, and live amongst them, and do our best to mitigate the evils arising from them. He thought there was a certain amount of inconsistency between the opening remarks of Dr. Percy Frankland and the conclusions the Chairman came to with regard to rabies in dogs. Those portions of the paper which dealt with facts—the basis for knowledge—commended themselves very much to his mind, and he thought the author had done great service in putting before the public the firm foundation on which the germ theory rested. He had brought forward only those facts which had been incontestibly proved, but there were a great many others slightly referred to in the concluding remarks, and it was with some of those he wished to deal, namely, the connection of germs with disease. This was a subject to which the Chairman

of that evening had paid a great deal of attention, and being one of the leading surgeons who had investigated the injurious action of microbes on wounds, he (Dr. Carpenter) would be glad to have the advantage of his criticism on what he was going to say. An objection had been raised to the germ theory from the fact, as proved by observation in the paper, that these germs existed everywhere, and it was said, if that were so, and these germs which produced so much mischief were everywhere, how was it that any individual who was subject to pathogenic mischief was not infected? how did anyone escape from the influence of any disease in the world, because, if the germs were everywhere, everybody would be liable to their influence? At first sight that appeared to be a strong objection to the theory; but he would refer to other scientific observations as an analogy. Take the formation of ice for instance. If water were about the temperature of 32°, you would be certain to get ice formed. If the temperature were raised one or two degrees, the ice would disappear. But persons who lived in parts of the world where ice was unknown, might say that it was impossible to make water solid, but that was simply from ignorance of the facts. Now, with regard to a disease germ, if instead of considering the temperature you consider the chemical constitution of the receptive solution, whether one of those used by Dr. Frankland or the human blood, if you get a certain chemical constitution, the germ would take root and reproduce its kind; it must have a proper seed bed into which to drop to enable it to grow. The observations of Dr. Frankland with regard to the effect of drying and destroying these organisations point to some of the reasons which explained their activity at one time, and their non-activity at another. But there was another point of great importance. All these disease germs had various conditions of existence. For instance, he would take one not referred to in the paper—that of small-pox. That disease was, he was convinced, just as much due to disease germs as some other diseases which had been proved to be actually thus caused. That small-pox germ was a very peculiar one. It had been thought that no one could resist the influence of small-pox germs who had not been vaccinated if he was exposed to their influence, but he very much doubted that. There were individuals who had no condition in their liquids which would allow of that particular germ taking root, nothing which enabled the small-pox germ to increase and develop in the blood. The aim of medical science should be to find out what it was that produced this condition of things, and thus render an individual insusceptible to small-pox, because when the conditions were once known, they might be extended to all. It had been found how this could be done in one way by vaccination; you could render a person insensible to the small-pox germ by vaccination, but only for a time, and so it was with the natural condition of an individual. A certain individual was to his knowledge insusceptible to small-pox and vaccination, for he attempted in vain to vaccinate him for this cause, and when exposed to small-pox, he did not take it; yet twelve years afterwards, the same individual got small-pox very badly. His constitution had altered, the condition of his fluids had changed, and a state of blood was produced which allowed the growth of the germ; some excretion had been produced in his blood which allowed the germ to grow, and it was upon the excreta, and especially the excreta of human beings and animals, that these pathogenic germs did grow. If that excreta could be got rid of, washed away in water, and dealt with in water—it could be done—an immense deal of small-pox would be prevented. It was by allowing them to dry and disperse in the atmosphere, or by drinking them in water, that these germs were taken into the body, and if the constitution was in such a state as allowed the germ to grow, in consequence of some excreta being present which ought to have been got rid of, the disease germ would grow, and set up the diseases so clearly described by Moses in the book of Exodus. He thought the author had scarcely given sufficient credit to the older writers, for in the Book of Exodus there was a description of these very germs and organisms that were to produce fevers and inflammation, the botch, emerods, and other plagues which affected the Egyptians—all coming from these organisms, which were developed in consequence of disobedience to the laws of health. Again, 200 years ago Robert Boyle described the action of ferments as being similar to inflammation, and it was only the knowledge of the ancients which was brought out more clearly and conclusively by microscopic and chemical observations in modern times, and thus a great deal was now known which the ancients could not possibly know, because they had not the means of observing it. To return to the small-pox germ, it was of a threefold character. There was no doubt that the presence of a small-pox hospital gave rise to a tendency to small-pox in the neighbourhood; and it had been thought by some that this was caused by germs which floated from the hospital. He did not believe that, having investigated the question very thoroughly. He believed that a small-pox patient being conveyed through the streets of London, even in an ambulance, a person coming in immediate contact with the breath from the patient, might, by chance, be infected—that it was the living, growing germ from the breath which tended to spread the disease. Frequently, if the germs did not get into the air in this way, nature had placed a limit to their vitality; they must be transplanted at once from the mucous membrane of their host to that of a new recipient, in order for the latter to become infected. If the germs floated through the air for 50 or 100 yards, or perhaps 25 would be sufficient, they lost their vitality. This was the case with a pure atmosphere; but there were conditions, especially

the presence of acids, carbonic acid particularly, which tended to preserve the vitality of these disease germs; thus, if carbonic acid were got rid of by lime whitening, which absorbs carbonic acid, the vitality of such disease germs would be destroyed, and with it the danger of infection. Again, there were small-pox germs which were not living but dormant. These existed in the pustules themselves, they might be carried to any distance, and might infect any individual who was susceptible. Besides those, there were others which were already growing much as malted barley grew. And if they were transplanted, small-pox would be produced. Unless the disease were treated on the system of destroying these three kind of germs, small-pox would not be entirely got rid of, and it was because this was not done—those in the excreta, for instance, would be destroyed without paying attention to the living and growing germs which came from the breath—that there was not that complete removal which was capable of being brought about by attention to the natural history of germs, and it would apply not only to this disease, but to a large number of others of an infectious character. There was a great deal in the paper which was very suggestive of inquiry, especially in connection with this question of infectious disease. He had not of late been able himself to follow out the chemical and microscopic investigation of this question, owing to a partial failure of sight, but some years ago he was closely occupied in studying matters connected with the development of these disease germs. Some ten years ago, at a meeting of the Sanitary Institute at Croydon, he read a paper on disease germs. The President, Dr. W. B. Richardson, then looked upon the term "disease germs" as a misnomer, and rather held to the idea that it was a glandular production which produced fatal results in those who died of infectious disease. On that occasion he stated that it was possible that the germ theory partisans were right, and that Dr. Richardson was also right; and that the glandular theory had its origin in this manner—that it was not the germ which killed, but the secretion of their bodies, or the materials they produced in the blood of their host, which led to death; in fact, that they produced poison. His impression was that that was probably an explanation of many of the difficulties with reference to the presence of disease germs—on one occasion not producing mischief, and upon another occasion doing so. They had an analogy to that. Take for instance, a cat, which on some occasions you might stroke and do almost anything with, but if you excited it, and got it into a rage, and it bit anyone, mischief would sure to arise. The fact of an animal getting into a rage produced a saliva which caused great danger. If they had that condition of pathogenic germs, capable on one occasion of producing a poisonous secretion, and on another occasion producing a harmless secretion, they had then to find out how to get rid of the poisonous secretions, and to render the pathogenic germs harmless. Pathogenic germs were everywhere more or less; but what had to be done was to reduce the state of the host to that extent when the germs would be harmless. It was disobedience to the laws of health in producing material in the neighbourhood of towns, in congregations of individuals, amongst crowds, amongst individuals in being dirty and dissolute in their habits and vicious in their customs, which had led to the formation of material in their own bodies, by which a poisonous excreta resulted from the micro-organisms which led to death. If they attended to the laws of health, and were obedient to those laws, thus removing all excreta from their midst, they would do a great deal to mitigate the evil. The organisms should be made food for plants instead of being allowed to become the means of evil.

Mr. HOLTHOUSE said he should like to make a few remarks with regard to what had been stated by Dr. Carpenter, especially as to the fact that micro-organisms, although they pervaded the atmosphere, when they produced disease attacked only certain individuals; for instance, a person might be exposed to the contagion of small-pox on many occasions but yet not take the disease, and this might be explained upon the hypothesis that certain individuals were not susceptible to the action of these poisons, looking upon the micro-organisms as so many poisons. One of the best examples of that was to be found in the fact that during the summer season hay fever only attacked certain people. That showed the susceptibility of these people to the attack. Another way in which this could be explained was by the fact that micro-organisms came, on occasions, like a flight of locusts. He recollected on one occasion, when in Smyrna, noticing the sun which had been shining brilliantly all at once become very dark and gloomy; in fact it was thought that a heavy storm was coming on, but it turned out that this was due to a flight of locusts. If it was admitted that certain clouds of micro-organisms came at different times, they could account in a great measure for some persons escaping, and others being attacked. It was somewhat like the London fogs, which might be seen on one side of the river, and not upon the other. Persons might be upon the fringe of the micro-organisms, while others were in the thick of the mass, and others not in it at all. It was, at one time, thought that a great many diseases, such as epidemic catarrh and influenza, were brought about by changes of atmosphere and temperature, and no doubt they were, but they were not due solely to this fact. A mere cold would not produce the symptoms of catarrh. Anyone in the habit of seeing a large number of patients would have been struck with the fact that the patients on one particular day might all be affected with the same disease. This was not due to any remarkable change of temperature, but to some cause of the kind which he had indicated. Changes of temperature might affect persons

n this way, that moist and warm weather probably vivified some of the micro-organisms which were in in embryo condition, and thus made them more or less dangerous.

The Chairman said he supposed there was no physician in London who would venture to say how long the life of microbes lasted, or how long a time it would be safe to allow to elapse before allowing a child who had suffered from diphtheria to mingle with others of its own age, or to allow a child to wear clothes which had been worn by another child who had suffered from this disease. Sometimes surgeons were asked whether children who had suffered from this disease might go to school in a few days, and the answer generally was that they might go in about six weeks, but no one could say with certainty what time ought to be fixed. In many instances parents were not acquainted with the danger that existed, and children were allowed to return to school three weeks or a month after having had a severe disease, and thus the disease was spread through the school, and it was very difficult indeed to point out the particular individual, or to say who was the starter of the new infection. Sometimes it came from new quarters, but very often it came from the old cases. He had seen cases where children had been seriously attacked in this way, by being allowed to spread the contagion in school, when they should not have been allowed to return for a considerable time. No doubt there were many present who could speak upon this point, and he should be glad if they would do so. He remembered one case where the clothes of a child who had been ill were put away for a year, after which time they were worn by another child, when that child was attacked; thus proving that the germs had existed for the space of twelve months.

Dr. J. F. J. Sykes said he was acquainted with a number of works on micro-organisms, but he never came across a work in which the main facts had been so concisely and tersely stated as in the paper read by Dr. Frankland. That set him thinking in two or three directions of the practical utility of one or two facts—of one fact in particular, viz., the rapid gravitation of organisms. It struck him at once that that fact might be practically applied to hygenic arrangements for the sick room; one constantly saw useless bowls of disinfectants distributed about sick rooms. The proper place to disinfect would be the floor, and he saw no reason why it should not be possible to apply some powerful adhesive disinfectant upon the floor, so as to catch the germs and fix them. There was some utility, no doubt, in opening windows, and allowing an inlet of air, but oxygen was an aid to the growth of the germs. Fresh air diluted, but it did something more; it introduced non-pathogenic organisms, and, from recent experiments, it appeared that the non-pathogenic organisms were more powerful than the pathogenic, so that the introduction of organisms caused the struggle for existence to be much more severe, and the pathogenic organisms naturally succumbed. There was some utility in placing a sheet before the door of a sick room, as it prevented the germs from escaping to the rest of the house. These three points to which he had referred seemed to be very strongly confirmed by the facts which had been brought to their knowledge by Dr. Frankland. Dr. Frankland had not gone so far, although he had brought out certain fundamental facts which were very important. He could not understand why the oxidation by fresh air should be fatal to germs; for, reasoning by analogy, oxidation was the best thing for life, whether animal or vegetable. Why should the law of Nature be reversed when one was dealing with the lowest kinds of life. He could not account for this. The question of light no doubt played an important part, but it was not because the oxidation injured the germ, but rather that the masses of germs became diluted, and, in the next place, they came into competition with a stronger form of germ, and in that manner succumbed. The germicide that would destroy non-pathogenic germs would also destroy pathogenic germs; this fact had been brought out recently by Dr. Klein. With regard to germs floating in the air, he thought that if it were admitted that germs could be carried about, such as variola, it must also be admitted that they could travel in the atmosphere to any distance, provided they could float, and did not meet with conditions adverse to their existence. Those conditions, he presumed, would be fire or drying. If they were in an ovoid form, in all possibility they would not be destroyed by drying, and would survive. Doubtless they did survive, to a certain extent. If they were portable, they certainly could travel in the air, and it was not altogether proved that they could not do so. Typhus, for instance, was a particular type of fever, which, no doubt, was due to some micro-organism, but the extent of the infection was very small, because, apparently, the germs were killed in the atmosphere. They did not survive—they dried up. That must be due to the fact that they did not sufficiently rapidly assume the ovoid form so as to be wafted through the air. If they issued from the human subject in the ovoid form they were much more likely to be perpetuated than if they issued in a vibratile form; consequently, the very great difference between the distance to which different diseases spread might be due to the fact that the germs issued in a different metamorphic state. The question of oxygenation was very important. It was necessary to get out of people's minds the idea that the mere oxygenising of germs wonld destroy disease. He did not think it would. It would dilute it, and an individual would be better able to resist it; and the fresh air would also give the individual the pure oxygen in his own blood, which would enable him to resist

disease. He would like to hear Dr. Frankland's opinion on the question of oxidation, because it bore very materially upon the life of these germs and their nutritive medium, whether that were the human body or artificial cultivation, and he thought in that direction a great deal was yet to be done. On a subject of this kind, it was very necessary to be quite right from the commencement, because if you got misled at the first start, it was fatal to progress.

Dr. ONDAATJE said he was at one time connected with the superintendence of several provinces in Ceylon, especially the northern provinces, where cholera used to break out periodically owing to the intercourse of the Indian labourers with the natives of Ceylon. At one time the Indian Government supposed that the disease came from Ceylon, because on the return of the coolies to India, cholera broke out among them; but after considerable trouble and investigation he had satisfied himself that it was imported from India to Ceylon, and thence taken back again to India. In the hospitals the patients were entirely free from the disease; at any rate, there were very few instances and he knew one case of an old attendant, who had been in a hospital for 10 or 15 years, who was still living when he left Ceylon, and had never had any attack of cholera. With regard to the spread of small-pox, he had noticed that on one occasion a small-pox patient had been landed from one of the Peninsular and Oriental steamers in Galle, when Galle was the chief place for arrivals in Ceylon. This patient was placed in the small-pox hospital at Galle, and it so happened that one of the attendants stole a blanket belonging to that patient, and in two or three months there was a rumour that there was suddenly a case of small-pox. Nobody could account for it; the village was examined very carefully, and upon inquiry it was clearly proved that the disease had been spread through this blanket which had been stolen from the hospital.

Mr. LASCELLES-SCOTT said there were many points in the paper, but he could only take up one or two. He hardly agreed with the author as to the best mode of collecting microbes and counting them. There were certain objections to the method he adopted, and he himself had found no difficulty in using Hesse's mode, which was a tube lined with gelatine, through which the microbic air was allowed to pass. He had made one or two experiments himself, and found the same result as Dr. Frankland had stated with regard to the peculiar manner in which the organic germs shifted themselves, the majority of the bacteria appearing in the first part of the collecting surface, and then the moulds. He had found a very convenient mode of collecting and counting these organisms was to take a long tube, and fill it with small glass globes about one-third of an inch in diameter, which were coated with nutritive gelatine. He had also used discs of glass similarly gelatinised for the same purpose. It was quite unnecessary to say anything with regard to germs in ordinary air, but in corroboration of the results given in the paper, he might mention that he had had the opportunity of making a few observations on the air of Drury-lane Theatre on Boxing-night, 1886, and he would give a few of the figures. In the stalls, at 8 p.m., there were 245 organisms per 10 litres; at 11 p.m., 526. In the dress circle, at 8.30 p.m., there were 374, and by 11.15 the number had increased to 860. The character of these germs had been referred to by several speakers, some being pathogenic and some not; and it was said that of these pathogenic germs, sometimes they took root, as it were, in a human subject, almost unaccountably; and sometimes more unaccountably, when it was thought they ought to do so, they did not. He had made some experiments on the air of a small room, fifteen feet square, which might throw some light on this question. The room was kept purposely unoccupied for the previous twenty-four hours, and then, on three occasions, he had eight persons in the room, and after they had been there an hour and a-half, he examined the air and found the number of germs present to be on the three occasions respectively 210, 180, and 245, showing an average of a little over 200. On three other occasions he made similar experiments, but on this occasion all the persons present, except himself, were smokers, and the figures then came out after an hour and a-half, 116, 80, and 96, or an average of rather less than 100. This experiment might possibly teach a lesson which would be worth following out, and it suggested that the tobacco smoke there destroyed the germs, or their action. It had been said that opening a window, ordinarily speaking, only meant dilution, but it meant more than that. If you opened a window through which really fresh air entered, you had something more than mere nitrogen, oxygen, and carbonic acid, you had ozone, or the combination of oxygen called peroxide of hydrogen, and in either of those forms oxygen had its powers of oxidation very much intensified. Dr. Carpenter had descanted upon what he called the bad qualities of these micro-organisms. Dr. Frankland rather put before them subjects worthy of examination, and which were different types—good, bad, and indifferent. There was one point which Dr. Frankland had not touched upon at all, and that was the influence of some of these micro-organisms in the production of chemical principles, or wha was popularly called alkaloids. Might they not look forward to a period when these organisms might be made to produce beneficent alkaloids, as those for the benefit of disease, and, therefore, in one sense, we might find a few more good qualities in micro-organisms than Dr Carpenter felt inclined to allow to them.

Dr. ALFRED CARPENTER said he should like to have some explanation from Dr. Frankland with

regard to one or two points in his paper; the question which he should have put to him was whether it was possible for these microbes to attack a person who was perfectly healthy. It had been said, with regard to a tree, that if a tree was perfectly healthy, it was not likely to become infected with the fungus that would destroy it; if a plant or a field of potatoes were in a perfectly healthy condition that the potato rot would not affect it. He did not know whether that was so. It had not been proved one way or the other. He had an idea that it was possible that a person in perfect health, or an individual plant in perfect health, might resist the influence of parasites. The possibility of course was a very important one. If they could prove that health would enable a person to resist these influences, of course any person who was attacked by microbes in any form or kind would be undoubtedly out of health, or he would not have been attacked by them. There was another point, as to what fell from Dr. Sykes, which he should like to refer to, and that was that microbes were precisely like human beings, inasmuch as if they were all put together in a very small room, and that room was sealed up so that only air enough to breathe got in, and none of the carbonic acid got out, they would soon poison themselves. That was precisely what happened with regard to microbes, which disappeared rapidly from the scene—they poisoned themselves by their own secretions. Microbes that produced alcohol in beer were killed if that alcohol exceeded 20 per cent. There was a destruction of the yeast plant by excess of alcohol. So with regard to other orders. The microbes produced a kind of poison certainly as destructive to the microbe as carbonic acid, or any other material that came from human beings was destructive to human beings. He could not quite agree with Dr. Sykes as to oxygenation not being a source of evil to pathogenic microbes. He believed ventilation was the first principle connected with their destruction, and that the ventilation acted by the provision of oxygen in some form; it might be in that form referred to by the last speaker, somewhat different to that which existed in the ordinary atmosphere, or in that in which it was given out by plants which absorbed carbonic acid, and gave out oxygen, thus counteracting the influence of animal life on the earth, and they gave out this oxygen in the form in which it was highly destructive of disease germs. He questioned whether animals in health gave out germs which would be injurious to human beings, but he was quite certain that diseased animals, especially tuberculous ones, produced germs which had a very important influence upon human beings. When he was a student, it was thought that the diseases of animals had very little to do with the disease of human beings; but the more these matters were examined, as they had lately been by Dr. Klein and several medical officers of health, and others, the more proof there was that it was as important to the health of the community that animals should be healthy as it was that human beings should be. They were dependent on animals for food; and if the meat which we consumed came from animals infected with tuberculous disease, it was impossible for those who ate the flesh to be entirely free from evil consequences. It was said that heat destroyed germs, and he believed it did; but it required heat of a certain kind. Boiling would not destroy germs if the liquor in which it was destroyed was alcohol. You might destroy the growing forms, but not the ovoid forms. If the liquid were acid, however, the boiling destroyed them completely. That proved pretty conclusively, and in fact he had proved it himself some years ago in the case of the potato disease, having boiled some of the haulms of a diseased potato plant, then dried them, and spread them over the field. Those which had been boiled in acid water were unproductive of disease, but those which had been boiled in water in which there was lime, produced a remarkable effect on the crop.

Mr. Dickson said in one of the fever hospitals in London, there was, on one occasion, a young woman who was being treated for scarlet fever. She passed through the acute stage, when one Sunday afternoon a nurse from the adjacent small-pox ward, in disobedience to the regulations, came into the fever ward and stood at the foot of the bed. Shortly afterwards this patient had a most severe attack of small-pox. He mentioned this in reference to the opening observations of Dr. Carpenter, as to the probable means by which the spread of small-pox was effected, viz., from the breath of the person suffering from it. In this instance, however, it was an attendant of the ward, not a patient.

The Chairman said they had to thank Dr. Frankland for the very careful and admirable manner in which his conclusions had been laid before the meeting, and had led to such an interesting discussion. There were various ways in which medicine might be studied; some studied cases in one fashion and others in another. Those connected with hospitals dealt with disease principally in the clinical aspect, examined the patients, saw their symptoms, and considered the mode in which drugs acted upon them. Others, again, connected with hospitals, studied disease in quite a different fashion, viz., pathologically, they examined the organs of the men and saw what they had died from. That was pathology, whilst another mode in which it was examined was by minute anatomy by means of the microscope. There was still another mode very interesting, and that was the one which Dr. Frankland had placed before them—the etiology of disease or the mode in which it spread or

originated, and that was the most valuable of all. If they knew exactly how diseases began in a large number of cases, they might prevent their development. How diseases commenced, however, there seemed to be some difference of opinion. It was quite clear that mere disagreeable smells were not the cause of disease. On this point there was a capital paper recently written by Mons. Cazenove on the smells of Turin, in which he endeavoured to show that, vile as were the smells in that town, although the whole place was built literally on what might be called a festering mass of decomposition, being low and flat, and the river moving slowly, and the whole soil percolated with human excreta, as a matter of fact the town itself was rather healthy, as towns went, yet the odours in December were so bad as to drive him away, and what they would be in the middle of summer he would not venture to say. The absence of ill effects here seemed to be attributable to the great purity of the water that was supplied to the town, which came from a long distance. It would seem, as Dr. Pettenkoffer showed some time ago, that something more than mere putrefactive material was required; there must be some germ introduced. That was shown very well in the case of cholera; all the conditions for the development of cholera might be present, and yet it would not arise until some cholera germ had been introduced from without, and then the disease began, and it would often spread. He was not quite so clear with regard to Dr. Carpenter's remark that the excreta of human beings was not very unwholesome to human beings. In the Faröe Islands, it was well known that the people lived in huts so bad that even sailors would not go inside in spite of the cold, because the smell was so abominable; and although the natives lived to apparently a fair age, and were healthy enough; if a child was born, it almost invariably succumbed, in fact two out of three died from lockjaw. The excreta there appeared to be destructive to human life, and very few seemed to survive it. Again, with regard to the action of these micro-organisms, he hoped people would not go away with the idea that these things were always existing in a large number and of fatal character, floating in the air; if so, nobody would be there to talk about them. As a matter of fact, probably comparatively few were really pathogenic. In all probability the mode in which these things acted might be said to be divided into three methods: in the first place they might, having entered the economy, multiplied and developed, take away from the normal structure of the body materials from the blood or lymph which the structure required for the growth and development, and if any one would look at the sections now made by microscopists, and see the thousands and millions of these things there were in a small mass, he would readily understand that they were really like fungi which were sucking up the nourishment of the animal just as the black rust on wheat would take away the proper nourishment of the wheat plant. They might also act in a totally different way, viz., by their own excreta. These things produced certain materials as the product of their life and growth, their metabolism produced certain materials which, as they were inside the animal, had to get out by the blood and excreta of the animal, and produced a poisonous effect as they passed through. Then there was a third method in which they might act, by taking away from the materials of which the body were composed certain constituents, leaving certain poisonous materials—which had been referred to by one of the speakers as alkaloids—behind them, and so we were literally poisoned by the remains of the feasts on our bodies which these creatures left behind. There were two or three ways, at all events, in which these things might prove fatal to the higher animal. With regard to infection of disease, there was one point of importance which had been left out. It had been said that a thoroughly healthy man was not likely to be attacked by disease, and he quite coincided in that view. There was also another reason why, in most instances, those who were associated with hospitals rarely suffered—the absence of any nervous apprehension; they ventured into them with perfect calmness, whereas a man who went with fear and dread often became affected. He could say that positively with regard to cholera. He and others had seen in connection with various hospitals in London quite a mass of cholera patients, but it never struck him there was any danger. But if a man went in with great mental depression and fear that he would be affected, the disease would be much more likely to attack him.

Dr. Percy Frankland, in reply, said he could not attempt to take up all the points which had been brought forward, and some of the questions which had been put were quite beyond the range of his knowledge. One very important point had been raised by Dr. Carpenter with regard to the killing of organisms by boiling. There were various modes of boiling, and many things which were called boiling were not boiling at all. A scientific man understood by the term that condition of a liquid in which it was passing into a state of gas, in such a rapid manner that it caused ebullition, and at the ordinary pressure of the air this took place at the temperature of 212°. If organisms were exposed to this temperature in a moist condition, without exception, as far as they had been investigated, it was fatal to them, if carried on for a period of half-an-hour. There was no reliable instance on record of any organism having endured that temperature for such a time without succumbing; as a matter of fact, a much less period was generally sufficient, but still, in order to be safe, it was better to continue the process for that time. It is frequently recommended that milk, water, and other liquids used for dietetic purposes, should for security sake be

subjected to boiling, but this should be carried out in a rational manner. Milk, for instance, must be really boiled, not as was generally done, simply by putting it in a jug and placing the latter in a saucepan of boiling water, in which case the temperature of the milk would not approach that of boiling water. He had a case in his mind of a family affected with diphtheria, which was undoubtedly to be traced to the milk. The milk supplied was alleged to have been boiled; but when the matter was fully inquired into, it was found that the cook had done it in the way he had just described. She had, however, the audacity to say that the milk in the jug entered into such a rapid state of ebullition, that she had frequently seen it spurt from the jug into the fire. He need hardly say that anybody acquainted with the physical properties of liquids would know that that was absolutely impossible. Another question more directly connected with the subject of the paper was suggested by Dr. Sykes, as regards the bearing of these experiments on the precaution which ought to be taken in the regulation of sick rooms. The principles laid down by Dr. Sykes were entirely in accordance with all the experiments on the distribution and mode of dissemination of micro-organisms in air. It was obvious that on every surface on which organisms would fall some substance should be placed which would fix them and, if possible, at the same time destroy them, and it would not be difficult to devise some means of this kind. Carpets and plain wooden floors were calculated to very much increase the possibility of distributing these organisms through the air. A floor covered with oil cloth or waxed would obviously arrest any organisms which fell on the surface, and they could be readily removed with water, or if it were a wax floor, some disinfecting substance, such as corrosive sublimate, might be introduced so that those which fell on it would be very quickly disposed of. He took it that the beneficial effect secured by the opening of windows and ventilation was principally due to desiccation and not to oxygen at all. Most of these organisms not only multiplied and increased, but could only retain vitality in the presence of a suitable quantity of moisture; and when the open window allowed fresh air to enter, the various moist surfaces which always existed in rooms became desiccated, and the organisms which existed in the fully-developed state, such as bacilli and micro-cocci, would, in all probability, perish rapidly. It was only necessary to bear in mind the well-known researches of Koch on the power which the comma bacilli had of resisting desiccation, for he found that if they were dried and exposed to the air for half-an-hour, they were destroyed. The same had been shown in the case of a great many organisms. Organisms existing in the ovoid or spore-form, on the other hand, were not destroyed by drying in this manner. On the other hand, he could conceive cases in which the opening of a window might be detrimental; for instance, in hospital wards during the exposure of wounds; there might be a large number of the pathogenic organisms lying about the floor, and if the window were opened, the first thing which took place would be the conveyance of all these organisms into the air, and if any operation were performed in such a room the chances of infection of the wound taking place with the open window would be greater than with a closed one. Of course, the window must be ultimately opened to produce the beneficial effect of ventilation, but the time of opening should be duly selected. Dr. Sykes had also referred to the struggle for existence, which was believed to take place between the pathogenic and non-pathogenic forms. This point required great caution in dealing with, in fact the whole subject of bacteriology lent itself so easily to speculation, that it was necessary to be very guarded, and not to go beyond what the facts warranted. There was undoubtedly evidence of some pathogenic organisms being prejudicially influenced by non-pathogenic. The bacillus anthracis, for instance, was often weakened in its virulence, or sometimes destroyed, when put in competition with non-pathogenic or saprophytic organisms, but there was no evidence that this was the general state of things. In fact, he did not think any fundamental difference between pathogenic and non-pathogenic organisms had been established. There was nothing absolutely distinct in their physiology as far as was known, and, therefore, any generalisation made from the behaviour of one particular organism was hardly justified. There were cases on record, but few in number, because the subject was very difficult to satisfactorily make out, in which non-pathogenic forms were found to destroy either the virulence or the life of pathogenic organisms, and from this it was supposed that in the future some diseases might be combated by means of non-pathogenic organisms, but all attempts hitherto made in the direction had been entirely abortive, and almost ridiculous. He was referring especially to the attempts made in Italy by Professor Catani to combat tuberculosis, by making people inhale spray containing saprophytic organisms. Dr. Sykes stated that micro-organisms were always beneficially affected by the presence of free oxygen, but that was not the case universally. In by far the greater number of cases oxygen was essential to the existence of micro-organisms, but there were other micro-organisms which could only multiply in the absence of free oxygen. These were only few in number, and their study was more difficult than that of those which flourished in air. A pathogenie organism of this kind was the bacillus of malignant œdema. An organism of that kind would undoubtedly be destroyed, except in the spore form, in which form it could stand the presence of oxygen, just as the ærobic organisms could stand the absence of oxygen—in the presence of oxygen. Dr. Sykes also dwelt on the fact that, in consequence of this inefficiency of

oxygen to destroy micro-organisms, the latter might be expected to travel in the air with the same facility as they could be conveyed in culture tubes or like vaccine lymph, but that was not the case, because when they travelled through the air they must be dried up, and in that condition they would most of them perish rapidly. On the other hand, organisms in cultivating materials would retain their vitality for months and years. The idea suggested by Mr. Holthouse that the organisms in the air resembled flights of locusts, was quite mistaken; indeed, the difference in the number present in the air at different times and seasons did not exhibit such enormous differences as existed in the case referred to, where at one time there would be millions of locusts entirely darkening the air, and at another time none at all. In fact, the upshot of all recent investigation on the micro-organisms in the air tended to show that the number present was very much less than was previously believed, and that the places where large numbers became collected together were those where some artificial process was going on, *e.g.*, in a dusty street. In all places in which natural phenomena were going on undisturbed the number was comparatively small, immensely smaller than was formerly thought by Professor Tyndall when he conceived that most of those dust particles were living organisms. The interesting experiment of Mr. Lascelles-Scott showed that, even in such places as Drury-lane Theatre on Boxing-night, the number of organisms was incomparably smaller than the dust particles which were formerly thought to have an organised character. In conclusion, he would point out that it was very desirable in all these matters to be very careful not to speculate too rashly. It was a subject which naturally excited the imaginative and speculative faculty, and therefore it was all the more important to be cautious, and always to keep clearly in one's mind what the facts were which had been fully established, and to distinguish those from matters which existed only in the domain of fancy.

The CHAIRMAN then proposed a hearty vote of thanks to Dr. Percy Frankland for his excellent paper, in which he set forth a number of results which would form the foundation for much future work.

The vote of thanks having been carried unanimously, the meeting adjourned.

Mr. Lascelles-Scott writes in correction of Dr. Carpenter's statement that micro-organisms are killed by acids, and remarks that certain organisms live in alkaline, others in acid liquors, instancing the vinegar plant, lactic, and butyric acid fermentation, &c.

Miscellaneous.

WILLIAM SMITH'S GEOLOGICAL COLLECTION.

At the Natural History Museum, Cromwell-road, there has lately been opened a gallery of the palæontological department, in which, along with other historic collections, is placed that of William Smith, "the father of English geology."* Though this has been the property of the nation, and has been lodged in the British Museum, since 1816 it has not been seen, till now, as a collection, for the last half-century. The cause of this is, that though it was the nucleus of what grew to be a separate department—the geological—the way in which that department was developed led to dismemberment of the collection. Arranged by Smith himself originally, with the fossils placed on sloping shelves, to represent the south-easterly dip of the strata in the districts he knew best, it was found that the many additions from other sources could not be arranged in a similar way, and also that this dip, at the angle he had adopted, did not hold good for the whole country. Although contrary to an order of the Trustees that the collection should be kept intact, the specimens were used to help to form a general collection, and it became so completely lost sight of that, when Professor Phillips, in 1844, published his "Memoirs of William Smith," he wrote:—"The present state of this, the first stratigraphical collection ever made, is unknown" (p. 79). When Dr. Henry Woodward was first appointed to the department in 1858, he commenced reassembling the specimens scattered so widely through many cases and cabinets. Fortunately, it was a habit with Smith to write on the fossils themselves the localities in which he found them, so that there was no difficulty in recognising them. On the removal of the Natural History Departments from Bloomsbury to Cromwell-road, it was arranged that the historic palæontological collections, including those of Sir Hans Sloane, should be placed in a gallery by themselves. This has been done, and the Smith collection now occupies a wall cabinet, having an upper glazed portion which contains the specimens figured in the "Strata Identified by Organised Fossils" (marked with a green spot), or described in the "Stratigraphical System of Organised Fossils" (marked with red), both published in 1817. The remainder of the collection is in drawers underneath. Over the cabinet is a cast of the marble bust of Smith in the church of All Saints, North-

* William Smith was born in 1796, received an honorary LL.D. from Dublin in 1835, and died in 1839. It was at the anniversary meeting of the Geological Society that Professor Sedgwick, from the president's chair, referred to Smith the father of English geology.

ampton. A copy of William Smith's large map of England and Wales, coloured geologically (published in 1815), has been mounted and placed in this gallery in wall-case No. VIII. on the east side.*

This historic collection must always have especial interest for members of the Society of Arts, as it was the first among public bodies to recognise the value of his work and to reward it by a prize. In 1802, the Gold Medal of the Society or fifty guineas was offered for a mineralogical map of England and Wales, on a scale not less than ten miles to the inch, and in February, 1815, a premium of fifty guineas was awarded to William Smith for a six sheet mineralogical map of England and Wales, on a scale twice that for which the reward was offered.† The collection preserves some of the actual materials with which Smith worked in compiling the map. There were, of course, also his sections, notes and local MS. maps, but few of these have been traced, and it is known that most of them were destroyed by a fire that burnt his office in Craven-street.

The conception of "a delineation of the stratification throughout England," appears to have preceded his discovery of the "identification of strata by their organised fossils" by some ten or twelve months. A tour of 900 miles, in 1794, from Bath to Newcastle by one route and a return by another, when as their engineer he accompanied two members of the committee of the Somersetshire Coal Canal Company, had confirmed his idea formed when surveying for the canal that there was a regularity in the order of the strata, and this he then proposed to show on a map. But in this post-chaise journey he had relied for his facts mostly on hill contours, and the alternations of clay plains, and hill ranges. It was not till seven years afterwards that he completed his first small map of England (1801), now in possession of the Geological Society, though in the meantime he had coloured, geologically, a map of the neighbourhood for five miles round Bath (1799), and long before this, from 1795, he worked in detail, with the aid of fossils. The steps by which he was led to his discovery of the identification of strata by fossils can be understood by the following quotation taken from his memoranda, when read in conjunction with a knowledge of what his previous experience had been. As assistant to a land surveyor he had, between the ages of 18 and 22, surveyed in Gloucestershire, Worcester, Warwick, Oxford, and Hampshire, and from early farming habits noticed the different kinds of soils. Transferred at 22 to Somerset, he there noticed the same relative position of some of the "soils," and the accurate spirit-level work in surveying the whole length of the projected canal revealed to him a south-easterly dip of the strata, as he roughly put it, "like slices of bread and butter."* Then when he came to actually laying out the exact line of the canal, he says:—"the great similarity in the rocks of oolite on and near the end of the canal toward Bath, required more than superficial observation to determine whether those hills were not composed of one, two, or even three of those rocks, as by the distinctions of some parts seemed to appear. The doubts were at length removed by more particular attention to the site of the organised fossils, which I had long collected. This discovery of a mode of identifying the strata by the organised fossils imbedded therein . . . . . led to the most important distinctions." The actual construction of the canal was commenced in 1795, and in another MSS. memorandum he says, "and the canal excavations and the new quarries opened produced organised fossils for the identification of strata which could not have been otherwise distinguished." He soon found that none of the many people with whom he was brought into contact had ever noticed these facts, not even naturalists who had collections of fossils which they regarded in a zoological light. To show to others that his stratigraphical views were correct, seems to have been his motive in commencing a collection of fossils arranged stratigraphically. He uses the expression "vouchers" as if he expected some reluctance in others accepting his views. "These fossils were collected, written upon, and preserved in the order of strata as vouchers thereof." Up to 1799 his connection with the canal so confined him to the district, that his fossils ranged only from the coal measures up to the chalk, but after that date he had engagements in surveying for land drainage all over England, and thus he extended his collection. In 1802, it was arranged for inspection in Trim-street, Bath, and in 1804, it was removed to 15, Buckingham-street, Adelphi, where it remained till it was purchased for the British Museum, January 2nd, 1816.

Although from his bust, and from the title Sedgwick gave him, "Father of English Geology," he is generally thought of as an old man, it will be seen from the above dates that the various stages of his discoveries were made between the ages of 23 and 27, and he was not more than 46 when he parted, in dire need of money, with his collection. £500 was the amount granted by the Treasury, which was paid by instalments, as the work of arranging went on. In 1818, 260 additional specimens were added, for which a further sum was allowed.

Smith's map, and his collection of "vouchers," were made with a practical aim in view—the improvement of land. With theoretical geology he had nothing to do, and it was the practical value of his work that was recognised by the Society of Arts.

* A copy of Smith's smaller geological map, together with twelve sections across various parts of England, coloured geologically, have just been presented to the Geological Department by Mr. William Topley, of H.M. Geological Survey of Great Britain. These will be preserved in the department with Smith's collection.

† William Smith also received a Silver Medal from the Society in 1805, for improving boggy land by irrigation.

* *Phil. Mag.*, Jan., 1833, p. 40.

AGRICULTURE IN HESSE.

The Duchy of Hesse is composed of 1,898,084 acres of land, 1,808,170 of which are productive, or about 95·5 per cent.; of these Starkenburg has 712,270 acres, Upper Hesse 777,486, and Rhine Hesse 318,413. In Starkenburg, of the productive land, 312,330 acres are farm and garden land, 85,613 pasture and meadow land, 1,721 vine land, and 312,604 acres forest land. In Rhine Hesse the proportion is 262,983 acres farm and garden land, 13 per cent. meadow and pasture land, 1·3 per cent. vine land, and 31 per cent. occupied by forest trees. The United States Consular Agent at Mayence, in his last report, says that the amount of agricultural land in the hands of private persons consists of 3,272,958 parcels, of which 3,070,246 amounting to 1,143,437 acres are worked by their owners, and 202,712 amounting to 161,345 acres are cultivated by tenants. The Grand Duchy has 165,535 independent proprietors of farm lands, of whom 59 per cent. hold less than one hectare, the hectare being equivalent to 2·47 acres, 25·20 per cent. from 1 to 5 hectares, 10 per cent. from 5 to 10 hectares, 3·80 per cent. from 10 to 20 hectares, 1·90 per cent. from 20 to 50 hectares, ·70 per cent. from 50 to 100 hectares, and only ·03 per cent. over 100 hectares each. This division of the farm land of the Duchy among so many proprietors, is looked upon as disadvantageous to agriculture in general, and as a great impediment to technical progress. The farm land of the Duchy is estimated to have a value of about £41,000,000 sterling, the value of the land in the little province of Rhine Hesse being put down at £16,000,000, while the large provinces of Starkenburg and Upper Hesse are put at £13,000,000 and £12,000,000 respectively. The vine land in the Duchy was estimated a few years ago to be worth about £4,000,000 sterling, of which that in the province of Rhine Hesse was considered to have a value of £3,000,000. There are 188 landed proprietors who own more than 100 hectares of land, 10 of them being in Rhine Hesse, 99 in Upper Hesse, and 79 in Starkenburg; 228 owning from 50 to 100 hectares, 36 in Rhine Hesse, 113 in Upper Hesse, and 79 in Starkenburg; 1,803 owning from 20 to 50 hectares, 615 in Rhine Hesse, 611 in Upper Hesse, and 577 in Starkenburg; and 6,363 owning from 10 to 20 hectares, 1,713 in Rhine Hesse, 2,718 in Upper Hesse, and 1,932 in Starkenburg. Wheat is grown chiefly in the Wetterau, Upper Hesse, and in Rhine Hesse, but less in the Vogelsberg; and in the Odenwald, and in the Rhine Main Valley spelt is cultivated in its stead, although wheat is still grown there, while spelt is not cultivated in Rhine Hesse and Upper Hesse. The highest per-centage of rye and barley is to be met with in the Vogelsberg, the Rhine Main Valley, Rhine Hesse, and Wetterau. In the Odenwald they are both less cultivated. Potatoes are cultivated throughout the land, and tobacco and hops are both grown in the Rhine Main Valley. In the Odenwald, and in Rhine Hesse, the latter are, however, but little cultivated, and in Upper Hesse hardly any of these crops are to be found. Flax is grown principally in Upper Hesse, but little in Starkenburg and none in Rhine Hesse. Hemp is very little cultivated in Upper Hesse, it is grown to a slight extent in Wetterau, and is much cultivated in the Odenwald. Around Mayence the culture of the grape may be said to form the chief occupation of the people. For hundreds of years the grape vine has been tenderly matured upon the banks of the Rhine. At the present time the Riesling grape is the favourite description cultivated, and it has taken the place of the famous Orleans variety, which used to be much planted in the Rheingau and in the better vineyards of Rhine Hesse, and to which the Rhine wine of the present day is said to owe its reputation, and which has given place, in consequence of its late ripening, to the Riesling. In the poorer vineyards on the low lands the grape known as the Oestricher is the one most cultivated. It yields more than the Riesling, and suffers less from the diseases of the vine, and in vineyards where the soil is heavy, a variety called the Kleinberger is grown, which yields a large crop of grapes, but of poor quality. During the thirty years, from 1850 to 1880, the cultivation of the leading kinds of grain has increased to a considerable extent in Hesse, while the production of leguminous plants on the other hand has diminished. It is calculated that Hesse produces about 1,075,000 centners of grain less than it consumes, the centner being equivalent to about 110 lbs. avoirdupois, and that, of potatoes, about 1,760,000 centners more are cultivated than consumed; but the over-production of the latter is used by the distilleries and starch factories, and as food for cattle. The production of barley and oats is hardly equal to the demand, and large quantities of maize, bran, and fodder have to be imported into the Duchy. Of rape, poppy, hemp, and hops, there has been a material diminution of cultivation during the last few years. In all the provinces it is stated that there is now only about half the quantity of these plants grown that were cultivated in 1850. The chief decrease has been observed in linseed, poppy, and hemp, and also rape, especially in Starkenburg and Rhine Hesse.

THE VINTAGE OF ANDALUSIA.

Her Majesty's Consul at Cadiz, in his last report, says that the vintage of 1886 throughout the province of Andalusia has been fully an average one as to quantity, and so far as any opinion can at present be formed, the quality promises to be good, as the weather greatly favoured the gathering of the grapes. The wines produced are those known as *Manzanilla* and *Montilla* sherries. The district of Jerez de la Frontera produces the finest qualities of sherry, and

in this district the vintage has been fully an average one. The gathering of the grapes was generally effected under favourable circumstances, although the latter part of the vintage was to some extent damaged by occasional wet weather. The yield in this district is calculated at from 18,000 to 20,000 butts, that is, about 2,000,000 gallons. Consul Joel says, that up to the time of writing, the 9th December last, the demand for the French market has been limited, although it is reported that large orders are pending, subject to the quality of the young wines when they become bright. In the district of Port St. Mary, owing to the scarcity of rain during the spring, the vines, although in a very healthy condition in the month of July last, did not promise an average crop, as the grapes had not then attained their proper size, but during the month of August there were some very heavy dews which proved beneficial, and the grapes filled out considerably. During the vintage the weather was extremely favourable, and the grapes were gathered in excellent condition, the yield being above the average. The San Lucar district produces the wine known as Manzanilla, and the vintage has been a fair one, although the quantity is less by 20 per cent. than that of 1885. The yield has been about 3,000,000 gallons. A large quantity of sweet wine has been made of the new juice blended with German spirit, and of this about 150,000 gallons have been already exported to Bordeaux and Cette. The district of Cordoba produces the wine known as Montilla, and the yield has been an average one, and the quality is expected to be good. The wine produced in the district of Huelva is a white wine of the sherry class, but greatly inferior to that of Jerez and Port St. Mary. The vintage of this district in 1885 was 8,000,000 gallons, and the 1886 yield has been in excess of that year. The product of this district commands a ready sale to French houses, who send representatives to buy it up in advance. It is shipped to Bordeaux, Cette, Nantes, and Havre, while a very small quantity goes to Hamburg. The price of the new wine has been from £6 to £7 per 100 gallons, including casks, which are generally the German spirit casks called *bocoyes*, containing about 120 gallons each.

ACCLIMATISATION OF ECONOMIC PLANTS.

The acclimatisation of new economic plants continues to be vigorously carried on in many parts of India and our Colonies by the aid of the several botanic gardens. This is clearly indicated by a perusal of the recently issued "Report on the Progress and Conditions of the Government Botanical Gardens at Sahárunpur and Mussoorie," for the year ending March 31st, 1886, and of the "Annual Report on the Public Gardens and Plantations, Jamaica," for the year ending September 30th last. Amongst a list of some of the more interesting additions to the Sahárunpur Gardens, may be mentioned the following:—1. *Acacia Senegal*, a tree said to be plentiful on the dry rocky ground in Sind and Rajputana, the wood of which is of a reddish-brown colour, takes a fine polish, and is used for weaver's shuttles. It yields the best gum arabic, known as Kordofan, White Senaar, or Senegal gum, and in Sind it is sold mixed with the gum obtained from *Acacia arabica*. 2. *Cedrela odorata*, the West Indian cedar. This is a tree closely allied to the Toon of India (*Cedrela Toona*), and the mahogany of commerce (*Swietenia Mahagoni*). The wood is of a mahogany colour, light, and even-grained, easily worked, and fragrant. It is the wood that is exclusively used for Havana cigar boxes, and canoes, or "dug outs," are frequently made from the hollowed trunks of the trees. It is, of course, not a true cedar, which is the produce of *Juniperus virginiana* and *J. bermudiana*. 3. *Cenchrus catharticus*, a grass known as "Bhurt" by the natives of Northern India, where the plant is found in sandy desert tracts. As a fodder plant it is much valued, owing to its young foliage appearing at a time when other kinds of grass are scarce. The grain is used as food by the poorer classes of natives in times of scarcity. 4. *Eucalyptus gomphocephala*. This is a tree of South-West Australia, where it is known as Tuart or Tooart. It grows to a height of 120 feet, with a straight, clear trunk of 50 feet without branching. It has a very close-grained and hard wood, used in Australia for ship building, wheelwrights' work, and for various other purposes where strength and durability are required. Very fine specimens of this wood were exhibited in the Western Australian Court of the late Colonial and Indian Exhibition, one of the finest examples of which has since been transferred to the Timber Museum at Kew. 5. *Myrica cerifera*, a fragrant-leaved North American shrub, the small fruits of which are covered with wax, which is collected by boiling them in water and skimming the wax from the surface, when it is formed into cakes and used for making candles. An allied species (*M. cordifolia*) is a native of South Africa, and yields a similar wax. They are known as wax myrtles. 6. *Sapindus saponaria*, the West Indian soap-berry tree, the fruits of which contain a large quantity of a saponaceous matter, used for washing cloths; the hard round black seeds are used as beads for necklaces.

On the subject of fodder plants Mr. Duthie, reporting on the sheep-bush (*Pentzia virgata*) says, "Last year I reported that this fodder plant was quite unsuited for this climate, but I must now modify what I then asserted, a single weakly plant survived the rainy season of 1884, and from it a number of cuttings were taken before the rains of 1885 began. The rains of the latter season were above the average; however, they did not injure the plants as in 1884, and I am now of opinion that this

plant may be grown in this climate with success. Every endeavour is being made to increase the stock, and I shall soon have sufficient plants for a small plantation."

An interesting communication is made on the subject of spider silk as follows:—Arrangements were made in June last with Mr. Docherty, at Bhim Tal, for collecting the supply of spider silk required by Mr. Wardle for experiments, as well as for exhibition at the Colonial and Indian Exhibition to be held in London this year. I arrived in British Garwhál early in October, just in time to superintend operations at the commencement. The men employed on this work were provided with small sticks about a foot long, and they were told to collect as many clean webs as possible during the day. There was not much to show at the end of the day, as the silk takes up very little space when wound round these sticks, and the weight is inappreciable. The total weight of webs collected during the season did not exceed 10 lb. The bulk of this was dispatched from here to Mr. Wardle in November last. The cost of collecting the above, and the carriage from Bhim Tal to Sahárunpur, and from Sahárunpur to Bombay, amounted to Rs. 33-7-0. At this rate the export of spider silk to England would, of course, never pay, but expenses might be reduced very considerably, for instance, this first consignment included the weight of the sticks round which the silk was wound. The silk is removeable after immersion in hot water, but not knowing what arrangements Mr. Wardle might wish to make for removing the silk from the sticks, I thought it better to dispatch it as it was. During my stay at Indalpur, in the Sháhjahánpur district, I saw some fine clean webs of the same kind in a forest about eight miles to the north of Indalpur; a large portion of this forest belongs to Pandit Ajudhya Pershad, and he was kind enough to have several of the webs collected for me."

Turning to the Jamaica report, under the head of economic plants, the following are enumerated as having been recently under notice:—*Gynocardia odorata*, a large tree of the Malay peninsula and India, from the seeds of which the well-known Chaulmugra oil is expressed, used in India in skin diseases, and recommended of late years in this country for similar diseases, as well as for rheumatic affections. It is stated that the reports of the medical department of Jamaica show that the oil is also used in that island for the treatment of the same disorders.

On the subject of Cacao (*Theobroma Cacao*), the following paragraph will be of interest. "The falling off in the demand for plants of this tree is no doubt, in a great measure, due to the extended period of drought experienced during the last few years; but it is hoped that the return of normal seasons will give confidence to planters by causing better growth to be made by the young trees already put out, which will encourage them to extend the area under cultivation. A very simple means by which the process of fermentation may be set up in small quantities of the 'nibs,' is to put them into an empty kerosine tin or 'pan,' and then place them in the full sun, taking care to cover the opening close with a thick cloth, so that the sun, striking on the outside of the tin, raises temperature. Two, or at most three, days is sufficient for this purpose; they should then be carefully washed with clean water until all the adhering mucilage has disappeared, then thoroughly dried in the sun. Cacao dried by this method brings a much larger price than that sent to market without fermentation, and the practice is one by which small cultivators could not fail to be largely benefited were it made known among them by clergymen and others who come into frequent contact with the people."

The tree Tomato (*Cyphomandra betacea*), about the value of which so much has of late been written, is said to be still in great demand, and large quantities of the seeds have been harvested and disposed of in exchange. "For the information of correspondents, it may be well to state here that the tree is suitable only for the temperature which it obtains in the hills of Jamaica. The temperature there seldom rises above 75° Fahr., and is seldom lower than 57° Fahr., the mean annual temperature being 63° Fahr. At lower elevations, which enjoy a purely tropical climate, the tree does not thrive. It commences bearing about the second year, and continues in fruit almost all the year round. It is mostly used as a stewed sweet dish, and can scarcely be distinguished from apricot. It may also be eaten in a similar manner to the common tomato."

Amongst other plants referred to in this report, as likely to prove satisfactory introductions, are Ceara rubber (*Manihot Glaziovii*), Para rubber (*Hevea brasiliensis*), Central American rubber (*Castilloa elastica*), and amongst the latest, the Demerara rubber (*Hevea spruceana*).

MINING INDUSTRIES OF NORWAY.

Mining is carried on in Norway for the extraction of gold, silver, iron, copper, pyrites of sulphur, nickel, cobalt, chrome, zinc, and lead, besides apatite and feldspar. The country, however, is not rich in ores and useful minerals, but in proportion to its great extent, and the amount of rocks, it is poor in this respect. Consul Gade, of Christiana, says that the districts richest in ores are the province of Buskerud with silver, cobalt, nickel, and iron; the provinces of Bradsberg and Nedenaes with iron, nickel, and cobalt; the provinces of Stavanger and South Bergenhuus with pyrites of sulphur and copper; the province of Trondhjem with copper and pyrites of sulphur. About thirty years ago the iron works formed still the most important branch of the Norwegian mining industry. The ores were chiefly produced at mines near Skien, Kragerö, and Arendal, and were smelted and refined in houses situated in the

forest districts, often very far from the mines. Next to them the copper works, all of which were, at that time, situated in the northern parts of the country, had the greatest importance. The silver works at Kongsberg, once the largest mining establishment in the country, came next in rank, and, finally, the cobalt works at Modum, and the chrome mines at Róros. The mining of nickel and pyrites of sulphur was still in its infancy. No mining existed in the Stavanger and South Bergenhuus provinces, nor in the most northern provinces, with the exception of the Alten copper mines. This has gradually changed, and the iron works have closed, or nearly so, while, on the other hand, the mining of pyrites of sulphur has become very extensive. The exportation of crude or half refined ores has increased, while the domestic smelting industry has fallen off. As regards the precious metals, the silver mines of Kongsberg have been worked since 1624, and have yielded silver amounting in value to about 130,000,000 kronor (the krona being equivalent to about 1s. 1d.). For many years they were worked at a loss, but have now for a number of years yielded a fair profit. At present they are the largest mines but one in the country, employing about 350 men, and have produced during the last few years from 6,000 to 7,000 kilogrammes of silver annually, with a net income for the Government of about 300,000 kronor. In the province of Nordland, especially at Vefsen, silver mining has been carried on since 1879, and silver ore has for some years been exported from the Svenningdal mines, but the veins vary very considerably. Silver ore mining has also for some time been carried on in the island of Hetteren. Gold has up to the present time been of no importance in the mining industry of the country. The principal copper ores in Norway are pyrites of copper, and pyrites of sulphur containing copper. The pyrites of sulphur, which contain too little copper to be used as copper ores, were formerly valueless, and were not mined, but from the year 1860, when there became a great demand for them as a material in the factories of sulphuric acid, they have been worked on a large scale in Norway. The pyrites of sulphur are exported in a raw condition, and the copper contained in them is only gained when the sulphur has been burned off at the sulphuric acid factories. The largest quantities of pyrites are to be found near Trondhjem and Bergen. The Róros works, which are Norwegian property, have been worked since 1644. With an annual production of nearly 300 tons of pure copper. they were, for many years, the most important copper works in the country; they are at present the largest mining establishment but two in the country. The Meraker works, in the province of North Trondhjem, produced, for a number of years, about seventy tons of copper annually. The Ytterólto mines, also situated in the North Trondhjem province, were originally worked for copper, but have latterly been worked on a large scale for English account, for obtaining pyrites of sulphur. As to the quantity of the ore, the mining here was, for some time, the most important in the country. Several mines were worked in the neighbourhood of Trondhjem, especially in the Meldal, and near Bergen, the Valaheien mines, besides others, were operated on a large scale for obtaining copper and pyrites of sulphur. The works on the Karmó Island, in the province of Stavanger, owned by Belgians and Frenchmen, were first operated in 1865, and are now the largest mining establishment in the country, occupying about 600 workmen. The shafts have been sunk nearly 500 metres. The Omdal works are operated by Englishmen, and employ from 100 to 150 men. Most of the nickel works which are owned by Norwegians, are situated in the eastern part of the country, viz., the Espedal works, the Rom works, in the province of Smaalenene, the Rengerige and Sigdal works, in the province of Buskerud, the Bamber works in Bratsberg, and the Evje works, in Nedendes; also in the Vaerdal and Senjen, far in the north. The production of nickel was very considerable between the years 1870–75, but fell off gradually owing to a fall in prices, and has now almost entirely ceased. The cobalt works of Modum have been worked for over 100 years, and have employed about 150 men. Mining of zinc and lead ores was carried on, about the year 1870, at the Konerud mines, near Drammen, and mining of zinc ores has also been largely engaged in, in the Ryfylke district. The chrome mines in the northern parts of the country have been very little worked since 1875. Of non-metallic minerals which have been produced in Norwegian mines, may be mentioned apatite, used in the manufacture of fertilisers, and feldspar, employed in the manufacture of porcelain. The former mineral is chiefly found between Langesund and Arendal. The feldspar mines of Odegaarden, in Bamber, have been among the largest establishments in the country, and are worked by a French company, which employs over 300 workmen. The feldspar is obtained from seams of granite, chiefly in the Smaalenene.

ARTS AND INDUSTRIES IN EASTERN AFRICA.

Domestic arts and industries have not yet reached a high state of development. Most of the agricultural implements are made from a hard wood, called "blackwood" or "coast ebony." The Makuas make a fine string from the roots of a tree termed *mlamba*. The Watussi draw out fine copper threads, with which they fabricate *niereres*, a kind of ring composed of giraffe-hair bound spirally with the metallic thread, and worn as leglets.

In Usambara, native talent has devised more than one form of musical instrument. A small clarionet, called *zomali*, about 18 inches long, and with a reed

mouthpiece, gives out sounds much resembling those of the Welsh bagpipe without the drone; it ranks second to the drum in public favour. The *pangu*, or *zeze*, is a double-stringed lute, in which half a calabash serves as a sounding-board. The *kwacha* is a shield-like board, about 2 feet long and 8 inches wide, rounded at the ends, into which two round notched sticks of hard wood are inserted, so as to form a curve over it; these notched sticks are then rubbed up and down with smaller sticks, so as to produce a rasping and most unmusical noise. A more capable instrument is the *viringa*, a large, rude, piano-like contrivance, formed of two thick banana-stems laid parallel, and of pieces of hard wood fastened crosswise between these, made so that those giving the highest notes are in the middle, the lower at each side. It is played upon by striking the notes with two sticks.

In the Masasi district ironstone abounds, and is utilised by the natives. They smelt this mineral in furnaces dug out of old ant-hills, and then forge hoes and axe-heads from the iron thus obtained. One of the chief employments of the people of Makua is the smelting and working of iron, the ore of which is procured from the hills of Chiga. The manner of working is very similar to that practised by the Ajawa or Yao tribe. The charcoal furnace is blown to a white heat by four separate blowers worked by hand, consisting of skins of a small deer, into each of which is bound a retort made of clay, the mouth leading into the fire. The anvil is a slab of granite; the hammer a heavy cube of stone, slung with fibre cord let into grooves at its sides. Hoes, knives, and axes are thus made at very cheap rates.

Every woman in Chole, south of Zanzibar, appears to be engaged in plaiting grass mats, which are largely exported. In this district, near each village, bark hives are fixed on cross branches about 6 ft. from the grouud, bees being very numerous, and the wax, of good quality, is brought to Samanga for barter. The Rufizi delta furnishes an almost inexhaustible supply of mangrove wood, which is shipped to the Red Sea and Arabia as "Zanzibar rafters." In the forests and jungles of this region the rubber vine (*Landolphia*) is plentiful, and the product is collected. The produce of the Mozambique coast consists chiefly of oil-seeds (*amendoim* and *gergelim*), rubber, ivory, copper, and wax. Rubber vines compose much of the forest in Masasi; the trees are gashed, as the escaping fluid soon assumes a pasty consistence, and is then rolled into orange-like balls for sale. Somaliland exports myrrh and incense; the forests of Usambara afford "ebony," copal, "teak," acacia, rubber, orchella, betel-pepper, prickly smilax, and other useful plants. The Bagamoyo coast exports copal, grain, semsem, ivory, wax, and rubber. On Lake Ugombo the hard reed-grass called *miombo*, when beaten, rubbed, and twisted, makes splendid rope, while another reed termed *mdete* affords excellent material for sun-blinds. The finest timber tree met with in Gaza is a species of *Gardenia*, known as *umshanatse* or *mapani*, furnishing planks 2 ft. wide and 40 ft. long. In Usambara gates to towns are made from the wood of a species of *Acacia*, called *mkongolo*, black within and white without, which is so hard as to almost withstand the attacks of white ants. The *mbungu* vine (*Landolphia*) is known from Pangani to Handei, and the copal tree (*shakasi*) is abundant in the woods adjoining the inner side of the wilderness of Usambara.

THE DRUGS OF MAURITIUS.

Medicinal plants have been but little studied in Mauritius. A remedy for dysentery is sought in the *ipica sauvage* or *ipica du pays* (*Tylophora asthmatica*). A decoction of the slender thread-like stem of the parasitic *tsihitrafototra* (*Cassytha filiformis*) is given for intestinal derangement, and as a tonic for scrofulous and rachitic infants. An oleoresin resembling elemi, probably produced by *Canarium Colophania*, is employed in the form of plaster as a detersive. The yellow juice which flows from the incised stems of the guava (*Psidium pomiferum*) is used as an application to ringworm, and a skin disease called *tampane*. The wood of the shrub *liane poilly* (*Embelia micrantha*) is administered as a tonic, and given in decoction for nephritis. The leaves and seed of the *sogar gota* or *cadoque* (*Cœsal-pinia Bonducella*) are used for certain diseases, and the seeds, powdered and mixed with pepper, constitute a febrifuge. Small senna (*Cassia occidentalis*) is used in asthma, and as a fomentation in some skin diseases. A decoction of the root possesses diuretic properties, and the leaves are used by the negroes, when smeared with a little candle grease, as a substitute for adhesive plaister.

Correspondence.

RAILWAY BRAKES.

My attention has been directed to the long letter, signed by Mr. Kapteyn, the manager and secretary of the Westinghouse Brake Company, which appears in the *Journal* of the Society of March 18th, appended to the discussion on Mr. Marshall's paper on brakes.

Many of the statements made in that letter are most inaccurate and misleading, and having regard to the fact that Mr. Gutch (the manager), Sir Henry Tyler (the late president), and Mr. Kapteyn himself (the present secretary of the Westinghouse Brake Company), had full opportunity of addressing the meetings, but did not venture then to put forward the statements made in the letter, it does not

appear to me that I should be justified in asking you to occupy the *Journal* with a detailed refutation of those statements, which they would undoubtedly have received at the hands of many of the practical railway engineers present at the meetings had they been then put forward.

I think, however, that in fairness I am entitled to ask that they should not be allowed to go uncontradicted. To justify my contradiction, I will only give one incontrovertible instance of the inaccuracy of the statements. Mr. Kapteyn states that the vacuum brake ought to have been debited with the list of killed and injured persons at Penistone. Now, Mr. Kapteyn is fully aware that the Penistone accident was the subject of three days' trial at the Manchester Assizes, in 1885, when the plaintiff alleged that the accident was due to the use of the vacuum brake by the railway company, and every effort was used by supporters of Mr. Westinghouse's system to induce the jury to come to that conclusion. After full trial, the jury found a unanimous verdict in favour of the railway company, and yet Mr. Kapteyn now ventures to make the allegation referred to.

I could point out other misstatements, equally glaring, but I do not feel that it is necessary to do so, having regard to the fact that the agents of the Westinghouse Company did not venture to make these statements during the discussion, when they could have been discussed and refuted.

HAROLD BROWN.

7, Walbrook, London, E.C.,
24th March, 1887.

THE APPLICATION OF GEMS TO THE ART OF THE GOLDSMITH.

I am much obliged to Mr. Edwin W. Streeter for pointing out an inconsistency in my paper of March 15th, which had escaped my notice in the hurry of correcting my proof.

The weight of the Orloff diamond should be 779 grains, instead of carats, that is to say the precise equivalent to the 194¾ carats quoted by Mr. Streeter in his work on gems, and by other authorities. My instance of the overrating of abnormal diamonds hereby acquires its proper force, inasmuch as the actual cost of the Orloff diamond has been estimated by the contemporary authorities, in the proper currency of the year 1766, at about 135,400 guineas, while, in 1797, Thomas Thomson, M.D., of Edinburgh, stated its value to have been at least £4,854,728 pounds sterling. The Orloff diamond was related to have been the eye of the identical image of the god Vishnu, worshipped by Brahma, and to have been looted by a French grenadier, who, in order to carry out his design, had contrived to be appointed a priest of the famous Seringam Pagoda, whither pilgrims flocked from all parts of India, with money offerings, to procure absolution. Deserting to the British at Trinchinapeuty, and thence to Madras, he sold the diamond to a trading captain for 20,000 rupees, by whom it was resold to a Jew for the sum of about £17,000. We are not told what sum it realised when it became the property of the Greek merchant, Gregory Suffras, who, in 1766, sold it in Amsterdam to Prince Orloff on behalf of Catherine II., Empress of Russia. In his "Nouvelle Exposition du Règne Minérale," revised about 1766, De Bomare related this last anecdote while yet the facts communicated to him were quite fresh in his memory. Louis Dutens, a contemporary writer and mineralogist, whose social position afforded him the best sources of information, makes similar mention of the transaction.

I observe that in Mr. Edwin W. Streeter's published work on gems, 1877, he states that "the Orloff was purchased by Russia for £90,000 sterling, and a pension of £4,000 for life," giving its weight at 194¾ carats.

In Mr. Streeter's present communication to the *Journal of the Society of Arts* he says that the sum paid for the Orloff was £90,000 in cash, and an annuity of £1,000 a year, giving the weight as 193 carats.

Which is the correct account?

ALFRED PHILLIPS.

March 28, 1887.

PURITY OF BEER.

In last week's *Journal* Mr. Salamon makes several corrections of minor errors that occurred in the reprint of his paper on the above subject. One very grave error, relating to the quantities of sugar used in brewing, must be rectified. I have, on many occasions, used the statistics given by the Commissioners of Inland Revenue in their reports, notably the 28th, p. 150. The arguments I and others have deduced from these, makes it of some importance that attention should be directed to them, while I ask Mr. Salamon the reasons why so wide a difference exists between the official figures and those used by him. I cannot understand how there has been an "increase of 18 per cent. in the use of sugar since the repeal of the Malt Tax," if those words are to have the significance attached to them that would naturally occur to every hearer or reader.

I have endeavoured to obtain this information privately, but, I regret, without success, so that I might with promptitude rectify any error of my own, had I inadvertently or ignorantly committed one. There are special reasons of very great significance why the particular figures used by me should be proved correct, and that all arguments based on them should be quite logical.

To reduce the discussion to this one issue, I will tabulate the figures officially given, and as I know them, for the five years only about which any discussion need arise, and content myself with asking—Where is the error?

Reports of Commissioners of Her Majesty's Inland Revenue.

	Year ending Mar. 31.	Year ending Dec. 31.	Year ending Sept. 30.	Mr. Salamon's Figures. [Date ?]	
	Cwts.	Cwts.	Cwts.	Tons.	Cwts.
1879	1,101,936	1,066,687	1,043,992	52,200	[1,044,000]
*1880	1,136,434	1,333,510	1,320,590	66,029	[1,320,580]
1881	1,280,134	1,125,342	1,141,747	56,267	[1,125,340]
1882	1,142,845	1,142,187	1,156,909	57,109	[1,142,180]
1883	1,130,811	1,126,353	1,126,924	56,317	[1,126,340]

* The Malt Tax was repealed September 30, 1880.

H. Stopes.

General Notes.

Brussels International Competition of Science and Industry, 1888.—Decrees of the King of the Belgians respecting the "Grand Concours," already mentioned in the *Journal* (see *ante*, p. 159), have been lately issued. The Minister of Industry and Public Works has been appointed President of the Commission, and H.R.H. the Comte de Flandre, the Honorary President. Vice-presidents and secretaries of the various sections have also been appointed.

Industrial Partnerships.—A competition for essays on the principle of admitting workmen to a direct participation in the profits of an industrial enterprise, started by the Strasburg University, has recently taken place. Dr. Frommers gained the prize, and according to the *Eisen Zeitung*, his arguments deal with the fact that the arrangement in question has never been other than a novel form of paying wages, in which, as a rule, only the better classes of workmen have participated. Attention is called to the circumstance that this plan has only been successfully tried where the results of a commercial undertaking are more or less directly dependent upon the workpeople, while it has not been found to answer where skilful management and a favourable situation of the market are the principal conditions of success. Moreover, the arrangement has never served to keep workmen away from social movements organised for their supposed welfare.

MEETINGS OF THE SOCIETY.

Cantor Lectures.

The Fourth Course will be on "Machines for Testing Materials, especially Iron and Steel." By Prof. W. C. Unwin, F.R.S. Three Lectures.

Lecture III.—April 4.—Tests of other kinds.—Shearing and crushing tests.—Tests of stone and cement.—Smaller testing machines.—Endurance tests. Relations between mechanical tests and chemical properties and modes of manufacture. Circumstances which affect the results of tests.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. W. C. Unwin, "Machines for Testing Materials, especially Iron and Steel." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Rix, "Harvesting."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. Edwin Ault, "The Shone Hydro-Pneumatic Sewerage System."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Discussion on the papers of March 7th. 2. Dr. J. M. H. Munro, "Further Notes and Experiments on the Composition and Manurial Value of Filter-Pressed Sewage Sludge."

East India Association, Westminster Palace Hotel, S.W., 2½ p.m. Mr. Oswin Weynton, "The Commercial Products of Assam."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m., Mr. S. R. Patterson, "The Pedigree of Coral Reefs."

Tuesday, April 5...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. E. A. Clowes, "Printing Machinery."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

City of London College Science Society, 8 p.m. Mr. C. E. Sohn, "Our Drinks."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. John H. Scott and Prof. T. Jeffery Parker, "A Specimen of *Ziphius* recently obtained near Dunedin, New Zealand." 2. Mr. Richard S. Wray, "Some points in the Morphology of the Wings of Birds." 3. Mr. W. F. Kirby, "A Revision of the Subfamily *Libellulinæ*, with Descriptions of new Genera and Species." 4. Mr. F. E. Beddard, "Contributions to the Anatomy of Earthworms." (Nos. I., II., III.)

Colonial Institute, Prince's-hall, Piccadilly, W., 8 Prof. T. Rupert Jones, "The Mineral Wealth of South Africa."

Wednesday, April 6...Geological, Burlington-house, W., 8 p.m. 1. Mr. Frank Rutley, "On the Rocks of the Malvern Hills." (Part II.) 2. Dr. C. Callaway, "A Preliminary Inquiry into the Genesis of the Crystalline Schists of the Malvern Hills." 3. Dr. C. Callaway, "On the Alleged Conversion of Crystalline Schists into Igneous Rocks in County Galway."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Mr. J. Bailey-Denton, "Metropolitan Sewage Disposal."

Thursday, April 7...Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. Prof. R. Meldola and Mr. F. W. Streatfield, "Researches on the Constitution of Azo and Diazo-derivatives. Diazo-amido-compounds." (Part II.)

Mathematical, 22, Albemarle-street, W., 8 p.m.

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FRIDAY, APRIL 8, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COLONIAL AND INDIAN EXHIBITION REPORTS.

The Reports on the Colonial Sections of the Exhibition, prepared under the direction of the Council of the Society, at the request of H.R.H. the Prince of Wales, Executive President of the Exhibition, and President of the Society, were published last week.

The volume, containing over five hundred pages in demy octavo, is published by Messrs. Clowes and Sons, price 10s. 6d. Members of the Society can obtain copies at the reduced price of 8s., by applying to the Secretary.

CANTOR LECTURES.

The third and last lecture of the course on "Machines for Testing Materials, especially Iron and Steel," was delivered by Professor W. C. Unwin, F.R.S., on Monday evening, 4th inst.

A vote of thanks to the lecturer was passed on the motion of the Chairman.

The lectures will be printed in the *Journal* during the summer recess.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. Barrett, Mus.Bac., Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing Monday, 23rd May, 1887.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Friday, March 25; Major-Gen. J. Michael C.S.I., in the chair.

The paper read was—

INDIAN COFFEE: ITS PRESENT PRODUCTION AND FUTURE PROSPECTS.

By Frederick Clifford.

Introduction.

India, we know, has taken the place of Ceylon as the chief producer of coffee among the British Colonies and dependencies. A subject worth consideration, therefore, is the prospect of permanence which this industry possesses, and some of the conditions, favourable or unfavourable, under which it is carried on. In the presence, probably, of some gentlemen practically conversant with coffee-planting, I must begin by disclaiming any authority as an expert. Although deeply interested in the success of coffee-planting, as an owner of estates in Southern India, my information in this paper is derived not from residence or personal observation, but mainly from reports and figures supplied to me by managers on the spot and from a study of official documents. During the Colonial and Indian Exhibition an interesting paper was read by Colonel Campbell (formerly of the Mysore Commission), who entered fully into the particulars of outlay and return upon coffee cultivation in India. I shall not here attempt to go over this ground. For other information, more detailed, and at the same time more picturesque, relating to a planter's life and surroundings, with his methods of cultivation, his early struggles, and discouragements, reference should be made to the interesting works of Mr. R. H. Elliott, Mr. Hull, Mr. Lester Arnold, and other practical coffee-growers.

Exports from India.

At the outset we are confronted with the fact that since 1880-1, from various causes, the export of coffee from India, and therefore its production there, has almost continuously declined. In 1885-6, indeed, the quantity shipped was the largest on record, amounting to 43,000 cwt. in excess of 1884-5, but this was a result due to unusually heavy crops, and not to extended

cultivation. When the figures for 1886-7 come to be published, the season's crop will, I fear, be found the smallest during the previous decennial period, showing a fall of not less than one-third in the quantity exported, for the short crops which are reported in Brazil and other countries have their counterpart throughout India, and especially in Mysore, to which my own information especially applies. Here are the returns of coffee exported from India during the last ten years:—

	cwts.		cwts.
1876-7....	302,489	1881-2....	346,364
1877-8....	297,327	1882-3....	353,324
1878-9....	341,186	1883-4....	340,025
1879-80 ..	359,313	1884-5....	328,317
1880-1....	369,357	1885-6....	371,027

Allowing for last year's exceptional crop, these figures do not show satisfactory results. But, considering the drawbacks with which planters have everywhere had to contend, it is perhaps something that in Southern India they have been able to hold their own. As it is, placing the principal exports of 1885-6 from India in order according to their estimated value, coffee stands tenth on the list, thus:—

	Lacs of rupees.
1. Grain and pulse	1760·81
2. Cotton, raw	1077·72
3. Opium	1073·55
4. Seeds	994·83
5. Hides and skins	533·46
6. Jute, raw	435·53
7. Tea	430·61
8. Indigo	378·31
9. Cotton twist and manufactures..	363·55
10. Coffee	134·84

Tea-growing, though a younger industry in India, now stands seventh in the list, and during the same ten years the exports of tea have progressively increased as follows:—

	lbs.		lbs.
1876-7..	27,784,124	1881-2..	48,691,725
1877-8..	33,459,075	1882-3..	57,766,225
1878-9..	34,432,573	1883-4..	59,911,703
1879-80.	38,173,521	1884-5..	64,162,055
1880-1..	46,413,510	1885-6..	68,784,249

Indian coffee-planters cannot, unfortunately, point to a similar ever-increasing demand in England for their special products.

Area under Cultivation for Coffee.

In the Statistical Tables for British India, compiled by the Department of Finance and Commerce, and published at Calcutta in 1886, 187,541 acres in Southern India are reported as under coffee cultivation with mature plants in the year 1884. Divided into districts, the following results are shown:—

Mysore	82,462 acres.
Madras	56,247 ,,
Coorg	42,300 ,,
Travancore	4,305 ,,
Cochin	2,211 ,,

The Madras returns include the Nilgiri hills and the Wynaad, important homes of coffee. Only nine acres are grown in Bengal. These figures do not show the whole area under coffee cultivation, but only that occupied by mature plants. Unfortunately, the figures are so defective that the official compiler himself admits that it is not possible to make any useful comparison with former years.

It will be of interest to compare these figures with the fuller and far more satisfactory details furnished in this valuable volume as to the growth of tea-growing industry in India. In 1875-6, the first year of the series supplied, 124,836 acres were under tea cultivation; in 1884, the acreage was 267,710. Thus, within these ten years, the acreage under tea in India increased by 115 per cent., while the out-turn increased by nearly 149 per cent.

Outside Mysore, the acreage under coffee seems to have been considerably reduced. For example, 263 plantations in Malabar have been abandoned since 1877. In many cases this land was unsuitable for the growth of coffee through too great rain-fall and exposure to the south-west monsoon, and other causes. In Coorg, the area appears likewise to have diminished through disease and unprofitable crops. On the Nilgiris, and in Travancore, the planters have turned their attention to tea; in 1884, 5,550 acres were under tea cultivation in those districts.

Besides the area occupied by mature coffee plants, the returns show approximately, during the three years 1881-3, the acreage under immature plants, and that taken up for planting, but not yet planted, throughout Southern India. The total area occupied by coffee in all stages of growth, and of land taken up for coffee, is as follows:—

	Acres.			
	1881	1882	1883	1884
Mysore	166,369	144,736	141,215	141,716
Madras (including Malabar and the Nilgiris)	133,591	111,468	108,358	110,328
Coorg	77,474	75,922	74,074	73,199
Cochin	7,702	8,251	8,251	7,819
Travancore	14,645	12,894	11,386	13,361
	399,794	353,286	343,346	346,432

In 1885, the return shows in Madras, in round numbers, a total area under cultivation of 65,000 acres, giving an approximate yield of 12,241,544 lbs., and an average yield per acre from mature plants of 218 lbs. In Mysore, there was an area of 104,500 acres, yielding 4,892,987 lbs., or an average crop from mature plants of 59 lbs. per acre ! In Coorg, the total yield from 49,300 acres is returned at 8,975,680 lbs., or an average yield of 212 lbs. per acre ; while Cochin shows an average yield of 414 lbs. per acre from 2,650 acres, with a total out-turn of 920,000 lbs. ; and Travancore 262 lbs. an acre from 4,800 acres, with a total crop of 1,129,480 lbs. I cannot say upon what basis the estimates of crop rest, but in Mysore half a cwt. per acre is a wholly inadequate yield ; six or seven times that quantity would not be too high an average produce.

Distribution of Exports from India.

Owing to the reduced or stationary consumption at home, efforts have recently been made by Indian planters to open up fresh markets abroad. Some of my own crop last year was, for the first time, consigned to Marseilles, and I know that planters have visited Genoa, Alexandria, Cairo, and other places, in order to establish, if possible, commercial relations there. For many years Indian coffee has been in demand at Mangalore, Calicut, and other ports on the West Coast, for export to Arabia. Native dealers visit the various estates in my own districts (Sullabile and Bali-Honur), buy what is termed "native" coffee, and send it by bullock-waggons to the coast, where it is re-purchased by Arab merchants, and shipped in their dhows to ports in the Persian Gulf. Here it is treated, and I believe that a good deal of it ultimately finds its way into the English and other markets as Mocha coffee. Thus the Arab traders have little to learn from those of more civilised countries in the art of making the most of their opportunities.

As little seems to be known in England of the extent to which Indian coffee finds its way direct into foreign markets, I will give here a Table showing the quantity exported from British India during nine months of 1886 (from April 1 to December 31), compared with the corresponding periods in 1884 and 1885. These figures are taken from the last report issued by the Government of India (Department of Finance and Commerce), and published by order of the Governor-General in Council :—

	1884.	1885.	1886.
	cwts.	cwts.	cwts.
To United Kingdom ..	55,679	55,903	81,611
Austria	586	517	2,875
France	101,452	78,205	92,024
Egypt	3,904	6,647	9,420
Arabia	6,429	11,760	7,325
Persia	8,469	9,809	6,624
Turkey in Asia	5,800	6,860	5,343
Other countries	1,700	8,988	10,120
	184,044	178,689	215,342

This Table does not include the three months, January, February, and March, in which coffee is chiefly shipped to England. It shows, therefore, the apparent anomaly that France receives more than the United Kingdom, a result probably due to the fact that the later shipments consist, to an unusually large extent, of inferior qualities, picked late in the season, or kept apart from the home supply. England and France take the bulk of the exports. In 1884-5 about 34,000 cwt. were sent to Persia, Asiatic Turkey, Arabia, Egypt, and the East African coast.

It is disappointing to find that the United States make no separate appearance in this return, although they contain a population who are said to drink eight times more coffee than tea. Indian producers may be pardoned for the belief that, in restricting consumption mainly to Brazilian and South American qualities, drinkers of coffee in the United States deny themselves the enjoyment of its more delicate and aromatic properties. But it is difficult to turn the accustomed course of trade, or oust a commodity with which the national palate has become familiar. Three or four years ago a strenuous attempt was made by Indian tea-planters to stimulate a

demand for their product in Australia and the United States, but I believe the result has not answered expectations. It will be seen, on the other hand, that Mahomedan drinkers of coffee value Indian growths, and that an appreciable proportion of our exports finds its way to Asiatic Turkey, Egypt, Arabia, and Persia.

Native Coffee.

Probably the larger part of this consumption consists of the cherry or native coffee before mentioned. This term is not necessarily, as might be supposed, limited to coffee grown by natives, but comprises berries from immature trees, or berries which drop from the trees, and are not sent to the pulping-house. Having no proper appliances for stripping these berries of their pulp, the natives expose it in the sun for about a month, until it is thoroughly dry. The same method is adopted in European plantations when the coffee is not thought good enough for the English market. On a young plantation of my own, in the Bali-honur district of Mysore, the whole crop of five tons has been so treated this season, and sold to native dealers. The natives use a primitive process, called "pounding-out," for separating this dried pulp from the bean. A small heap of the dried berry (or cherry coffee, as the planters call it, from its resemblance when picked to the black-heart English cherry) is placed in a hole scooped in the ground. A man, or sometimes a woman, pounds this with a pole, until the beans, or the greater number of them, are extracted from their outermost covering, when a fresh lot is taken. The result is a substance resembling chaff, or bran, mixed with coffee-beans. These are separated by women, in a light bamboo tray, shaped not unlike a housemaid's dust-pan. By a peculiar action of the hand, difficult to describe, the tray is jerked forward, so that the light refuse-husks approach the front, or lip of the tray. These are then pushed out, the beans are heaped together, and successive trays-full are similarly dealt with, until at length the whole crop is disposed of. Not having seen the process mentioned in any of the planters' books, I give this description of it, sent by one of my sons. In rural districts the natives excel in this method of separating the pulp and bean, as they clean their rice in the same fashion, pounding the grain to free it from the husk. Little of this native or cherry coffee reaches Mincing-lane from India, except, perhaps, in the guise of Mocha, or mixed with Mocha, but it finds a ready market among Mahomedans outside India, and is also shipped to Trieste and Marseilles.

Land Tenure.

In British territory, where coffee is grown an acreage tax is always levied. In Coorg this tax is two rupees an acre, but is not paid until twelve years after the land is taken up, so that the planter may have a crop out of which to meet this outgoing. Mysore, as a native State, maintained, until 1885, an Excise duty upon both coffee and cardamoms. On coffee this duty was one rupee per cwt., which, upon a crop of four cwt. per acre, amounted to an onerous tax, and was felt to discourage good cultivation. On the other hand, the Government derived no revenue until crops were yielded. Jungle lands were, therefore, taken up for coffee as a speculation, and often remained long uncleared in the hope that such lands would rise in value, and with a view to re-sale. Thus a tax upon the producer, besides being difficult to collect, diminished the receipts of the Government, and was not in the interests of *bonâ-fide* planting.

Coffee land in Mysore may now be held either on a perpetual settlement, subject to an average tax of a rupee and a half per acre, or on a thirty years' settlement, with an average duty of one rupee. Grass land not suitable for cultivation, but held along with coffee land for feeding purposes, pays at a lower rate. In grants of jungle, the Government reserve the right to seven timber trees, including sandal, teak, and black wood; but the occupier may fell, free of charge, any such timber, except sandal, if for his own *bonâ-fide* use. He may also buy all these reserved trees upon the estate, except sandal, at a fair valuation, paying the purchase money by instalments. Or, again excepting sandal, he may fell these trees for sale upon paying a royalty or seignorage. The Government likewise reserve the right to precious stones, gold and other minerals, including coal, but upon re-entry in the exercise of this right full compensation must be given to the occupier for all damage done. When lands are held in perpetuity upon the full average assessment, the owner has a preferential right to work any mines on paying a royalty of not more than 5 per cent. upon the gross proceeds of any gold or other minerals, and of not more than 10 per cent. on the value of any precious stones. On the whole, this Settlement of March 24, 1885, has fairly

protected the interests of British planters in this important coffee centre of Southern India, and their tenure is practically as secure as that of their fellow planters in the neighbouring Presidency.

Supply of Labour.

A difficulty in obtaining labour would not be expected amidst a teeming population like that of India. But this difficulty exists in some districts. Near villages the problem is simple enough. There you can generally have as many hands—men, women, and children—as you want, and when they are wanted. In the jungle, however, where new coffee lands are generally opened, labour has to be attracted from considerable distances. As there are no villages in which coolies can be received, the planter has to begin by building coolie "lines," as they are called. Money is well spent in making these abodes comfortable and healthy. Bamboo, easily procured, is chiefly used, and is an excellent material for such buildings. The walls are plaited bamboo, over which clay is plastered till it looks like a wall; the roof is grass-thatched. The coolies cater for themselves at the nearest market or bazaar, but it is necessary for planters to keep a stock of grain in store. In times of scarcity or famine, the people are driven from their villages to seek work, and labour is plentiful enough. At such times, European capital and enterprise, scattered all over India, save thousands of lives, by means far more prompt and certain than any relief camps or other machinery within the reach of Government. If for this beneficent result alone, British investors in India should receive every encouragement.

When there is no particular stress upon them to work outside their own village land, the natives, like people in the same condition of life, or, indeed, in every condition of life, all the world over, have no particular inclination to go far afield for employment. But labour must be had, or crops would neither be raised nor gathered. The planter must either himself beat up for recruits, or employ intermediaries to do so. He naturally chooses the latter alternative. Then his troubles begin. His agents cannot act without advances to meet their own expenses. The coolies they engage must be able to leave some rupees behind them to support their families in their absence. These advances at once beget temptation, both among the coolies and the "maistries" who engage them. Defaulting maistries and runaway coolies vex the souls of most planters. If you pursue them, for example's sake, time and temper are sorely tried, in a dilatory legal process, before a native court, and you get small satisfaction, often none; restitution, hardly ever.

It is a vicious system. Planters cry out against it, and have tried to dispense with it, but with little success. The advance account on my own estate books, and probably those of most owners, tells a dismal story of bad debts wiped off, and doubtful debts carried to suspense. In a correspondence with the British Resident at Mysore last year, Mr. Buchanan, Honorary Secretary of the North Mysore Planters' Association, stated that he had ascertained that the amounts then outstanding against defaulting labour contractors made a total of over 50,000 rupees in the Kadur district alone; and he added that, under the existing laws, planters were quite unable to recover this money, as no proceedings could be taken against the contractors in question outside Mysore territory; they were safe by just crossing the boundary into Madras. We all protest against the system of advances, but it flourishes in spite of protests. Its worst feature perhaps is that a planter can never feel sure how much, if any, of the advance has reached his coolies. Maistries sometimes exact heavy interest upon money lent by them to coolies, though the money really belongs to the planter. This extortion goes on, of course, without the planter's knowledge, though the coolies are made to believe that he demands and receives the interest. If a planter does not speak Canarese, the local dialect, he is almost at the mercy of roguish maistries and overseers, and cannot protect his workpeople from injustice and robbery.

We will assume that there is no fraud in the first hiring, and the advances made on account of it, and that each maistry starts with his gang of coolies to fulfil their engagements. For police or sanitary purposes, or both, these gangs are stopped on their march at each police-station along the road, and toll is sometimes demanded here before they are allowed to proceed. On reaching the estate, they may find the damper, colder climate in the hills unsuitable to their constitutions. In Balihonur, for example, the thermometer in the early morning is at 52°; at two p.m. it may stand at 94°. Natives, again, are quite as liable as Europeans are to attacks from dysentery or jungle fever. They take fright and desert if fever or cholera carries off

any of their number; or if, through accident in felling the jungle trees, they think an estate unlucky, and haunted by the wood demons in whom they believe.

No doubt it must often happen that coolies are deceived by false representations made to them by maistries as to work or wages, or they become home-sick, or anxious about their kith and kin left behind. Supposing that they have worked out their advances, small blame to them if, in some of these cases, they decamp with a few rupees of earnings. A coolie, it is said, can easily feed and clothe himself on one-third his earnings upon a coffee estate in Southern India. Like the negro, he seldom works for the sake of saving money; but here, again, human nature is very much the same in Europe as in India.

While many excuses can be made for natives who repent their bargains and wish to go home, the planter is probably in despair for want of labour to clear or weed his land, make or mend his roads, attend his nursery, or pick his ripening berries. In a letter received by this week's mail from one estate, the manager says:—"All my Ghaut labourers are leaving me through illness, and I don't know where to turn for more. The labour question is most wearying." With a view to avoid some of the existing difficulties, the Mysore planters are trying to arrange for a regular supply of Tamil coolies from Tanjore, Tinnevelly, Madura, and other districts in the extreme south of the Madras Presidency which send labour to Ceylon. Although you cannot rely upon the Canarese for labour just when it is wanted, they have many good qualities if their idiosyncracies are studied, and they are kindly and considerately treated. They seem to work best with their own tools in their own fashion. Some of you may have seen a sketch of three natives toiling at one English shovel. A barefooted coolie cannot force it into the ground, so in the sketch three of them are struggling with the shovel, one with a rope to haul it over or on the ground. The picture represents, truly enough, no doubt, the failure of many attempts to make natives use model European implements.

But it is unjust to represent the natives of India as obstinately opposed to all novelties. When they clearly see an advantage from new inventions, they are not slow to adopt them. For example, kerosene oil from the United States is now used everywhere in India, in towns at least, for illuminating purposes, and has largely displaced the vegetable oils formerly employed by natives. In 1885-6, over 20,000,000 gallons of mineral oil were imported from the United States; in the previous year, 26,000,000 gallons. The bazaars are full of cheap glass lamps for burning this mineral oil. Lucifer matches, in value over 20 lacs of rupees, are now imported annually (chiefly, I am sorry to say, the cheap Swedish matches), and have quite displaced the old sulphur-tipped sticks, which required the application of fire to light them.

Apologising for this little digression, I now return to our coolies. That they shirk work unless well looked after is a failing not confined to Canarese workpeople. "An Englishman chafes," says one of my estate letters, "to see them potter over a job, leave it for no known cause, begin again, and break off again, with endless delays and impotent excuses. Hindoo, or Mussulman, it is always the same; he cannot finish his work straight away. "Never do to-day what you can by any pretext put off till to-morrow," is a maxim he has learned from his earliest youth, and has inherited in practice from countless generations of ancestors. He is sick; it is a festival; something has gone wrong—it is an unlucky day; he wants two or three rupees on account for marketing. Mild and amenable as he seems, you will not, either by kindness or righteous wrath, overcome this ingrained procrastination. The monsoon is at hand, and you are in a fidget to get the tiles or other roof-covering on to your new store or bungalow. At last a beginning is made, and now you hope for steady work. Alas, no! There comes a messenger from the village of your best artisans. Somebody's daughter is going to be married, with great rejoicing. Somebody else's mother-in-law is dead. An old uncle has tumbled down a well; or fifty other events delay your work once more."

It will be gathered that, in his dealings with workpeople, a coffee-planter's lot is not entirely a happy one. Patience and forbearance, with firmness, are, in fact, essential. But his reward must be great if he can gain the respect and goodwill of a docile, temperate, and even too submissive people, and if at crop-time he can see men, women, and children earning wages for themselves and bringing fair profit to him. They are paid for each bushel of berries picked, and are thus under a stimulus to do their best. The work is easy; and the women and children with their agile fingers can generally reach the topmost branches and earn nearly as much as the

men. It is a harvest in all senses; healthy work, cheerfully performed and fairly paid, bringing comfort and plenty to many hundred native homes. This is piece-work; the ordinary rate of wages on a coffee estate is four annas a day for men and two for women.

Crops.

Upon a virgin soil, during favourable seasons, crops are recorded, in Southern India, as well as Ceylon, which fill the younger generation of planters with wonder and envy. Mr. Hull tells us that 25 years ago, before leaf disease blighted the prospects of coffee-planting in Ceylon, one estate there yielded a crop of 22 cwt. an acre, and 13 cwt. the year after. I have been told by a planter in Guatemala, that upon the wonderfully deep and rich soil there, 18 cwt. or 20 cwt. per acre can be grown, without manure, almost continuously, and that the planter can count upon a sufficient profit if he obtains an average price of 40s. per cwt. In Southern India, planters have learned, by sad experience, that coffee land may be soon exhausted, and requires a liberal return in manure. Another lesson is, that the coffee-plant, which is, we must remember, an exotic in India, requires protection, and flourishes best under shade. It is forced, indeed, into unnatural activity when exposed in the open, and for a time yields more than when grown under shelter, but seems to be soon exhausted, and then, naturally, falls an easier prey to insect plagues and disease. In Mysore, and most other districts in India, the coffee bush alluded to grows to a height of four or five feet, and is protected by such forest trees as are found to be congenial neighbours. Some trees do, and some do not, answer this description, and whether given trees are harmful or beneficial in the shade they give is a point to be studied. When coffee is grown under shade, and so kept from being over-stimulated by sunshine, planters have to be content with an average yield of from three to five cwt. per acre, depending upon soil, situation, and a free or stinted use of manures. A bumper crop is invariably followed by reaction and diminished production; the tree has given up its normal strength in making this effort, and next season requires rest for a fresh departure. Even five cwt. are a sad "come down" from the glorious crops of old. But according to the proverb, "he laughs best who laughs last;" and a cultivation to be successful must be based on conditions which promise permanence.

Effect of Low Rate of Exchange upon Production.

It is hardly possible to discuss any economical question concerning India without referring to the depreciated currency. Has a low exchange benefited Indian planters? Speaking from individual experience, I answer "Yes." Persons who are paid in rupees, and must remit home rupees, find a low exchange disastrous. A planter, on the other hand, sends home not silver but produce, which he sells for gold. With the proceeds he buys rupees at the rate, say, of 1s. 6d., and sends them to defray the cost of cultivation. On his chief expenditure, labour. the rupee goes very nearly as far as ever it did. It seems to follow that a planter in India gains largely from a low exchange. For instance, £75 in gold purchase silver which used to cost £100; and the equivalent thousand rupees have a purchasing power in India not very appreciably less than when the rupee stood at two shillings. The result must surely be that growers and importers of Indian produce are better able to meet competition in European markets, and that production must also be stimulated in India. Another result of a low exchange, in my case and probably in other cases, has been to lead to the opening out of fresh land for cultivation. Investors naturally think that a time when rupees are so cheap is a favourable time to buy them, and convert them into bits of jungle, materials, and labour, in a country where rupees for such purposes stand nearly at their old value. Hence, fresh capital has been attracted for investment in India, new employment has been found for native labour, and increased produce grown there for European consumption.

Authorities entitled to respect declare, however, that this reasoning is unsound, and leaves out of sight important factors which affect trade in a greater degree than exchange. Indian exporters, it is contended, do not really receive a larger rupee return for their produce than they received when exchange was higher, because prices of this produce in the home market have fallen in a proportion sometimes even greater than the fall in the exchange. Thus, the average rate of exchange in 1872-3 was 22·18d., in 1885-6 it was 18·25d., or a difference of about twenty per cent. During the same period prices in London fell as follows:—

Coffee	42·4	per cent.
Wheat	33·7	,,
Tea	34·0	,,
Cotton	38·6	,,
Rice (Bengal)	18·4	,,
Jute	17·4	,,

Any of my hearers who wish to enter more fully into this field of inquiry or speculation, will find ample materials in an able essay by Mr. J. E. O'Conor, Assistant Secretary to the Government of India in the Department of Finance and Commerce, published in a Blue-book of 1887, upon the trade of British India. Mr. O'Conor's conclusions are that any benefits resulting to Indian producers from the fall of exchange have been neutralised by a still heavier fall in prices brought about by the appreciation of gold. It may be that the price of coffee has fallen, in part, through the appreciation of gold. But I think the chief cause of this fall has been an enlarged area of cultivation in many parts of the world, and increased production, relatively, to consumption. In the essay under notice this factor is ignored.

Meanwhile, India is, year by year, adding to the appreciation of gold by withdrawing it from the circulation of the world, although Mysore is doing something to restore the balance, by extracting further supplies from its gold mines. In 1885-6, the net imports of gold fell off considerably, but in the previous six years twenty million pounds sterling in gold were absorbed in India, to be hoarded by native producers there.

Decreased Consumption in the United Kingdom.

I now come to a part of my subject which causes great regret to all producers and importers of coffee, a regret which should be equally shared by all who appreciate this delicious beverage for itself or as a substitute for alcoholic stimulants. First, the total imports of coffee into the United Kingdom have largely diminished, as the figures for the last eight years prove:—

	Imports. Tons.	Exports. Tons.
1879	80,900	64,400
1880	77,800	58,700
1881	60,600	47,700
1882	67,900	49,800
1883	69,900	48,700
1884	56,700	48,100
1885	51,800	36,800
1886	51,400	38,600

These figures, taken from the returns of the Board of Trade, prove, first, that much coffee which used to come to this country for reshipment now finds its way directly to its place of final destination. A still more serious fact is a stationary or decreasing consumption in the United Kingdom itself. During the foregoing eight years the quantity of coffee taken out of bond for home consumption has been in round numbers:—

	Tons.		Tons.
1879	15,500	1883	14,500
1880	14,500	1884	14,700
1881	14,300	1885	14,900
1882	14,300	1886	14,400

During January and February of the present year, the Board of Trade returns tell the same tale. The deliveries from bond for consumption during these two months, in 1885, were 53,458 cwt.; iu 1886, 52,498 cwt.; and in 1887 they fell to 46,608 cwt.

Notwithstanding the increase of population, therefore, less coffee is consumed year by year in the United Kingdom, a fact which is even more striking when our retrospect is extended.

In the year 1874, Mr. W. P. Branson read a paper before this Society, in which he showed that, down to the year 1840, when mixtures of coffee with chicory were for the first time allowed, coffee held an equal place with tea in public estimation, and their consumption was relatively equal. Since then, coffee has rapidly declined in favour, "strangled," as Mr. Branson tersely put it, "by its unholy alliance with chicory." I may appropriately quote here his Table showing the diminished consumption of coffee from 1847 to 1873:—

	Duty paid on.	Population.	Average consumption per head.
	lbs.		oz.
1847	37,441,373	27,105,000	22
1857	34,352,123	28,278,000	19
1867	31,567,760	30,151,084	16¾
1869	29,109,113	30,541,606	15¼
1873	32,329,920	..	15¾

Another calculation from a different source, but in substantially the same form, brings down the figures to a later date, and shows the average annual consumption of coffee, per head, of the total population, compared with

the consumption of its more prosperous rivals:—

	1860.	1870.	1880.	1883.
Coffee (lbs.)..	1·23	0·98	0·92	0·89
Tea „ ..	2·67	3·81	4·59	4·80
Cocoa „ ..	0·11	0·20	0·31	0·36

Causes of Diminished Consumption. Use of Adulterants.

You may easily suppose that all growers of coffee in India and the Colonies, and all persons interested in the import and sale of coffee, are much dissatisfied with this state of things, and ask to what causes it is due. That tea should increase in favour we can all understand. It is easily made; it is much cheaper than it used to be; and, perhaps, it goes further than coffee of the same value. We do not in the least grudge to tea its wonderful success, but there is room enough for both these refreshing, stimulating beverages. And when every allowance has been made for the natural advantages of tea, we ask, how it is that England is probably the only civilised country in the world in which the consumption of coffee does not increase with its increase of population?

One answer to this question is, that in the United Kingdom the adulteration of coffee is sanctioned by the Legislature. The Sale of Food and Drugs Act, 1875, on the one hand punishes dealers for adulteration, but, on the other hand, protects them if they sell adulterated coffee bearing a label "to the effect that the same is mixed" (section 8). As regards coffee, the consequences have been disastrous. Coffee mixtures have supplanted pure coffee so largely that, to quote a leaflet distributed to visitors by the Indian Coffee Committee, during the late Exhibition,—

"Large classes of the population hardly know the flavour of genuine coffee. Chicory is the chief ingredient in the cheap mixtures, because it soon makes hot water black, thick, and bitter, and so gives apparent strength to what may contain little of the coffee berry. Among numerous other substances used to adulterate coffee are burnt sugar, roasted and ground roots of dandelion, carrot, and parsnip, together with beans, lupins, and other seeds."

According to the same authority,—

"An analysis of 43 samples of coffee and coffee mixtures purchased in London during March and April, 1886, showed an average proportion of coffee in these samples of just 50 per cent., added to 50 per cent. of burnt sugar and various vegetable substances. Twenty-two of the samples bore a label very commonly used; and nine of those contained from 62 to 93 per cent. of chicory, &c., averaging 70 per cent. of other substances than coffee. These mixtures are sold at prices ranging from 10d. up to 1s. 4d. per pound. Upon a moderate calculation the vendors of many of the wretched compounds just mentioned must be realising profits of something like 100 per cent., and the worse the mixture the greater the profit."

Similarly, the annual reports of the Local Government Board show that coffee is one of the chief subjects of adulteration with which the inspectors under the Food and Drugs Act have to deal. We are told by the Board, in their report for 1884-5, that "it is no rare thing for so-called 'coffee' to be sold, which proves on analysis to be composed of one-fourth part of coffee added to three-fourths of chicory," and as chicory only costs 3d. or 4d. per pound, the sale of such mixtures is very profitable.

Mincing-lane is at one with growers of coffee in the wish to promote consumption by checking what are really more or less fraudulent practices, and an Association has recently been formed with a view to urge the Government to interfere. Chicory, as you know, bears the same duty of 14s. a cwt., or 1½d. a lb., as is levied on coffee. As far as fiscal arrangements can do so, it is thus raised to the same dignity as coffee, though it does little more than blacken the water and destroy the true aroma of genuine coffee. I will not weary you by entering at length into this vexed question. Some gentlemen in the City are of opinion that our Coffee Association should only ask for legislation requiring all dealers and retailers to declare on their labels the proportions of chicory or other adulterant used. In the view of the majority of its members, however, the Association should ask the Government to prohibit any mixture of other articles with coffee for purposes of sale, leaving the public to buy chicory, if they want it, and mix for themselves, a process perfectly simple and easy. They would then pay for chicory exactly what it is worth for infusion as a beverage, and that is very little. They would gain greatly in pocket by this separation; they would also become accustomed to the taste of genuine coffee; and we hope and believe that, under these combined influences, coffee would recover some of its lost ground. At all events,

it would not then be handicapped, as it now is, by a hateful union with inferior ingredients; a union which, as magistrates' cases all over the country show, opens the door for innumerable frauds, practised chiefly upon poor consumers, while it depraves the public palate, destroys the aroma and fragrance of genuine coffee, and discredits it as a national beverage.

Prices and Prospects.

In 1883, average Mysore coffee, of No. 1 quality, fetched, in Mincing-lane, from 90s. to 105s. per cwt. Since then, whether from appreciation of gold, or from an enlarged area of production outside India, prices have had a lamentable drop, realising no more than from 70s. to 85s. I omit exceptional brands of Mysore which have an exceptional reputation, and the price of which has undergone hardly any variation. Short crops in 1886-7 have given a welcome fillip to prices, and last week's sales of Indian coffee approached nearly to the old level. With prudent management, if a planter is able to avoid loans at high interest, I believe that coffee estates in Southern India will give a good return for the capital invested in them. Fortunately, the quality of Indian coffee, and the care used in picking and curing it, give it a far better position in the home market than the produce of foreign countries. Fluctuations in prices, as in 1879, and prices per cwt. of Ceylon coffee, relatively to those of coffee grown elsewhere, will be seen from the following Table, taken from a trade circular:—

Year.	Prices 31st December.				
	Middling. Plantation Ceylon.	Good ordinary Foxy. Guatemala.	Good ordinary. Java.	Good Channel. Rio.	Good average. Santos.
	Shillings.	Shillings.	Cents.	Shillings.	Shillings.
1879	101	71	48	69	72
1880	84	59	38	53	58
1881	75	50	33½	42	44
1882	70	41	27	34	35
1883	75	53	35½	54	53
1884	65	47	28	43	43
1885	62	40	25½	37	38
1886	80	65	39½	—	—

It is somewhat comforting to find that British grown coffee is worth twice that of the inferior coffee grown elsewhere. Compared with the bulk of foreign coffee, British production and home consumption are but as drops in the bucket. For example, the estimate of the world's crop of coffee in 1885-6 was as under:—

	Tons.
British India	17,000
Ceylon	11,000
Dutch India	59,000
Africa, Mocha, and Manilla	14,000
St. Domingo, Port Rico, and Jamaica	50,000
Costa Rica, Venezuela, New Grenada, La Guayra, Maracaibo, Guatemala, Salvador, Honduras, &c.	66,000
Brazil	370,000
Total	587,000

Or a reduction of 61,000 tons upon the actual crop of 1884-5.

It is more than a little galling to Indian planters to be told, as they are, that their coffee is so good that it is comparatively seldom drank by itself, being chiefly used to keep up the flavour of coffee mixtures which would otherwise be weighed down by the proportion of adulterants, and would possess little flavour of coffee. Rightly or wrongly, we believe, without underrating the claims of tea, that coffee of good quality, carefully made, and with a sufficient quantity for infusion, is, to quote the leaflet already mentioned, "the most delicious and refreshing of all non-alcoholic beverages;" that "it produces a buoyancy and exhilaration, followed by no reaction or subsequent depression;" that "it acts as a stimulus to the mental powers, lightens fatigue, sustains the strength, whether under mental or physical exertion, and contains medicinal and restorative properties long recognised as of the highest value." To preserve the purity and restore the popularity of such a beverage is surely worth a joint effort, alike by producers, by consumers, and by all of us who wish to promote temperance in drinking.

DISCUSSION.

Mr. Shuttleworth Brown said he had been much struck with some of Mr. Clifford's remarks, especially those in which he called attention to the direct importation of coffee from India to European destinations other than England. Some years ago, he hinted that in Mincing-lane there was great indifference as to whether coffee was consumed in England or not, it being considered that the broker

got his brokerage whether the coffee were re-exported or whether it were consumed in the country, and that perhaps led to some indifference as to adulteration on the part of those who ought to be interested in the subject. He had no Indian experience whatever, but the value of coffee as a beverage was a matter to which he had paid a good deal of attention, and he might point out, in confirmation of what had been already said, as to how the quantity of coffee consumed seemed to have decreased, that this was principally due to the effect of adulteration. There were four Government departments which dealt with coffee—the Board of Trade, the Inland Revenue, the Customs, and the Local Government Board. Several of these were in favour of purifying coffee, but one was quite indifferent about it; he hoped, however, they might all be won over in time. The beaurocratic aim was to make the most of the revenue, and the beaurocratic view was that pure coffee would do it. The sole question which the Chancellor of the Exchequer had to consider in such matters was the revenue, and he was afraid of making changes for fear of meeting with a loss; but if the unnatural insignificance of the total amount of revenue from coffee were properly brought before him, and still more, the despicable amount derived from chicory, he did not think they need fear much opposition on his part. Of course, Government officials must always be affected by considerations as to how their action would be looked upon by the constituents of the members who put them in office. Those who chiefly profited by adulteration were the shopkeepers, and since each average shopkeeper must have at least 100 customers, it would be much better for the Government to overlook the craving of shopkeepers for illicit profits, and to consider rather the legitimate interests of the consumer. He had always looked upon the word "Coffee" as the trade mark of the planter, and as such his legitimate property, and considered that if coffee were asked for it ought to be obtainable. With regard to the value of chicory and coffee as sources of revenue, he would submit the following figures:—In 1880, the imports of chicory were 16,276,000 lbs., the value being set down as £94,600; coffee, 1,546,000 cwts., and its value £6,861,130, so that the value of the coffee imported was exactly $72\frac{1}{2}$ times that of the chicory, or the value of the chicory was only $1\frac{1}{3}$ per cent. of that of the coffee. The exports in 1880 were: chicory, 2,388,295 lbs., value £26,303; coffee, 1,189,174 cwts., value £5,258,446. Thus, the value of coffee exported was exactly 202 times that of the chicory, or the value of the chicory was less than $\frac{1}{2}$ per cent. of the value of the coffee. The import and export trade together in coffee was over £12,000,000 sterling, whilst the total trade in chicory was only £120,000, an absurdly insignificant amount, making a total of 1 per cent. only of the trade done in coffee, and that in an article that was only employed to deceive, and as a source of illegitimate profit. At the same time, three halfpennyworth of foreign chicory shut out what might be ninepennyworth of Indian or Colonial coffee, and this affected seriously the interests of the coffee planters; and they were so important a body as compared with those who profited by dealing in chicory, that it seemed very unjust that their representations had not received more serious consideration. The consumption of coffee in England, in 1880, was 284,540 cwts., or ·92 lb. per head, but the consumption of tea was 4·59 lb. per head, or five times as much. The consumption in the navy of coffee, tea, and cocoa was practically equal, being nearly 1,000,000 lbs. of each per annum. The proportion in which chicory was mixed with coffee might be gauged by their relative consumption, chiefly by shopkeepers. Of chicory the consumption was, in 1882, 100,000 cwts.; in 1883, 103,000 cwts.; in 1884, 98,000 cwts. Of coffee, in 1882, 285,380 cwts.; in 1883, 289,715 cwts.; in 1884, 294,788 cwts. Thus, in 1882, rather more than one-third chicory was added to the coffee, which was gradually reduced to exactly one-third in 1884. Every one knew what he wanted when he asked or sent for coffee, viz., a stimulant—not colouring matter—whether he got coffee, or chicory, or a mixture of the two, but the demand for coffee had diminished, and the taste had become debased, because of the mixture being so commonly supplied. The net produce to the Customs for the year ending March 31, 1884, was from chicory, £68,050; from coffee, £194,192. £68,000, therefore, was the whole question the Chancellor of the Exchequer had to consider, but the public had to consider that the value of the chicory, on which they paid to the Chancellor of the Exchequer £68,000 for duty, was only £69,000; and then they had to consider what they paid for being cheated by it—how many times its commercial value. The remark had been made by Mr. Clifford that chicory was raised to the dignity of coffee by having the same duty placed upon it, but that was not the case in other countries where they are coffee drinkers. In France coffee paid a duty of £3 3s. 5d. per cwt. (as against 14s. in England), and chicory, in the dried state, $4\frac{3}{4}$d. only. In England, when roasted, it paid 13s. 3d., almost the same as coffee; in France, roasted chicory paid 1s. $7\frac{1}{2}$d. In Italy, coffee paid 100 francs per 100 kilos; chicory 5 francs if coming from a country with the most favoured nation clause; if no convention, 20 francs. In Germany, coffee paid £1 per cwt; chicory only 2s. In Austria, coffee paid 40 florins per 100 kilos; chicory, 15 florins. He thought no duty should be drawn from chicory, since it tended to legitimise its use, because it made adulteration to be no offence against the Revenue, and legalised this offence against the consumer; and he believed that if the duty (which only came to £68,000) were taken off, not a farthing would be lost to the revenue, because if it were made illegal to sell coffee mixed with chicory, or chicory otherwise than by itself, coffee would be sold in far greater quantity. The purpose of chicory was merely to make the coffee

look strong, but its effect was to deprive it of all its refinement of taste, and less coffee was used than if there were no chicory, and people were deceived by their eyes. The amount of revenue derived from chicory was so small that he thought there should be no hesitation in making a change in the law which would give people confidence in coffee, by enabling them to buy it unadulterated.

The CHAIRMAN remarked that it was very startling to see the enormous cultivation of chicory. He should like to know where it came from.

Mr. SHUTTLEWORTH-BROWN said it came almost entirely from Belgium. It used to be cultivated a good deal in Yorkshire, but within the last ten years it had almost ceased to be cultivated there.

Mr. W. P. BRANSON said the price of coffee in London depended really on the Brazil market. Brazil supplied nearly two-thirds of the total consumption of the world, and though it was mostly of a common quality, the quantity was so immense that, whether the crop were short or otherwise, it made a difference to the price all over the world. If he were a planter, he should not care two straws about the consumption in the United Kingdom so far as his own profits were concerned; the consumption here being only about 1 lb. per head per annum, it was utterly unimportant. In Brazil there had been an extensive system of slavery, which was now coming to an end, the number of slaves not being more tham a million at present, and probably in a few years there would be none. The future of Brazil coffee, therefore, was very uncertain, and if the production should fall off, the Indian and other planters would no doubt benefit. The coffee market had shown a considerable rise during the last six months, and although the whole rise might not be sustained, it was probable that a great proportion of it would, and if it held for this year, it probably would for the next four or five years. The coffee market was very peculiar, its fluctuations spreading over a period of eight or nine years, and being mainly affected by wars and money panics, chiefly the former. The greatest depression was the result of the American and German wars, which followed one another; it threw plantations out of cultivation by wholesale, and he believed this was the principal cause of letting in the coffee leaf disease. Some very strong remarks had been made about dishonesty and adulteration, which reminded him of what was once said by a cabinet minister :—" Don't talk to me about adulteration; it is all a question of price." The Government had been appealed to again and again during the last thirty or forty years, but everything they did only made matters worse. By recent legislation they not only allowed chicory but anything else if a twopenny label were put on the pound packet. Government did not care whether people drank potato-spirit for whisky, or saccharine for malt, or chicory for coffee, and it seemed to be hopeless to expect any improvement otherwise; the only sensible thing would seem to be to require the per-centage to be stated on everything sold as a mixture. In foreign countries, where the duty on chicory was much lower than on coffee, the mixture of coffee and chicory was not allowed to be sold. The Government were no doubt in fault and so were the traders, but after all, those most in fault were the English people themselves; they were generally very ignorant and negligent in all matters connected with the purchase and preparation of food, but especially so in the case of coffee. No one with any sense would waste money on buying ground coffee; you might as well buy a vintage claret in a quart pot. Chemistry had done very little for coffee; amongst other fallacies, it had been said that the volatile aroma of coffee was an essential oil; if it were, it would be bad enough to grind it up, but from many years' experience in dealing with coffee, he was satisfied that the aroma was something far more subtle than an essential oil; it was an ether, which was difficult enough to retain even in the whole berry, and he would not give much for coffee which had been roasted more than a week, but when it was ground up of course it deteriorated much more rapidly. A one pound packet of coffee was enough to scent a whole railway carriage, but the scent given off was simply the goodness of the coffee, and by the time it got home it was almost worthless; then it was often put into a tin canister, which made it ten times worse, and the result was, stale coffee for breakfast, which was worse even than chicory. He believed that was why chicory was used to improve the flavour of stale coffee. The practice of mixing was now about fifty years old, and it had got people into the way of buying their coffee ready ground instead of buying a 1s. 6d. mill and grinding it themselves. If they would only do that they need not appeal to Government, and would soon find grocers who would supply them with coffee freshly roasted every day. If people could be taught this, England would soon become a coffee-drinking nation, which would be an immense blessing to it.

Mr. TOLPUTT congratulated Mr. Clifford on his very able paper, in which there was only one point on which he would venture to correct him. That was with regard to "cherry" coffee, which he seemed to think was sold for Mocha. The latter, however, was generally the best native Mysore; cherry coffee was simply sold locally, and was prepared in the way described, because it was grown by small cultivators, who could not afford a "pulper" and "peeler." He believed coffee had a grand future before it. They had suffered during the last two or three years from short crops, caused mainly by unfavourable seasons, and to some extent by undue exhaustion of old plantations. If coffee was to pay the planter, it must be treated on the principles of modern scientific agriculture, and as he claimed to have been the pioneer of the modern system of manuring as applied to coffee,

he might say that the results were in every way satisfactory. He would point particularly to the Cochin district, not Cochin proper, but a small outlying district to which reference had been made, where there were some estates of which Mr. Lester Arnold had written. He had applied there the manuring system, and had found the result from the commencement to average 5 cwt. an acre, taking good and bad years together. The great difficulty was in dealing with men who had not followed the enormous improvements which had taken place in agriculture all over Europe. It was almost impossible to get the idea into their heads that a small quantity of carefully made manure would have as much effect as a basketful of muck; they had still much the same notion as many British farmers, that nothing could be manure which did not stink. He agreed with everything Mr. Clifford had said about adulteration, and would even go farther. If it were a crime, legally, to put sloe leaves into tea, why should it not be a crime to put chicory roots into coffee? But there were many worse things than chicory used. He was told by an analyst that in one sample he found a large quantity of animal matter and sugar, and he could not imagine where it came from. He said he could tell him; it came from maggoty figs and diseased dates. Some time ago he had occasion to pull up a man who manufactured large quantities of mixed coffee for pirating one of his coffee marks. He took the opportunity of learning a little about the manufacture, and he found that one of the ingredients used was roasted bullock's liver. These things ought to be generally known, for it could hardly be legitimate to poison the British public with roasted cat's meat under the name of coffee mixture. Why should not coffee be sold pure as tea was, and a Government officer be authorised to seize and destroy adulterated coffee just the same as adulterated tea? He feared they owed their last defeat in Parliament to an idea on the part of Mr. Gladstone that coffee was all the better for having chicory mixed with it. It was mainly owing to his opposition and that of Manchester merchants—who believed that Chinamen and Hindoos preferred to buy chalk instead of cotton in their goods—and to the late hour at which Mr. Cavendish Bentinck brought on the motion, that it was lost; but he hoped on the next occasion they would be more fortunate. Coffee growers ought to be grateful to a number of philanthropists who had endeavoured to deal with this question practically, by forming a company to sell pure coffee at the same price as the grocers sold it adulterated. It was no secret that a number of gentlemen put down £1,000 a-piece to form the Whole Berry Coffee Company, to see if they could not beat the grocers with their own weapons. He had no interest in it himself, but he knew they supplied pure coffee at a fair price.

Mr. W. STORR remarked that, if coffee planters desired to put down the sale of adulterated coffee, they might find a precedent in the prosecution of a great number of publicans recently for putting water into their beer. Only a year or two ago the Brewers' Association, finding the character of their beer was being damaged by the addition of water to it after it left the breweries, joined together, made an appeal to Parliament, and succeeded in passing a Bill without the publicans knowing anything at all about it, and when the law was put into operation, they were altogether taken by surprise. The public were learning through the heavy penalties which were being inflicted that it was an offence to put even water into beer after the brewer had delivered it. He did not see why the addition of chicory to coffee should not be treated in the same way.

Mr. HYDE CLARKE said his business with the coffee planters of India was as honorary agent for the planters of Western India, in 1857-8-9. Those were the early, struggling days of coffee-planting, and the first adventurers suffered much from the difficulties attendant on obtaining land. He brought their case before the Committee on English Settlements in India, which he obtained from the House of Commons, through Mr. William Ewart, and which published reports in 1857-8. The Board of Control affirmed against him that ten acres fit for cultivation by Englishmen could not be found on the higher waste lands, but the agitation resulted in obtaining the requisite facilities, and in promoting the enterprise of the large body of Englishmen, who were doing a great work for the benefit of the Empire, and of the people of India. In supporting the valuable and practical paper of Mr. Clifford, he would point out to him that the imports to Marseilles and Trieste, being mostly in bond, were re-shipped to Constantinople and Turkish ports, in displacement of the former shipments from London. As Mr. Clifford had stated, there was very little genuine Mocha coffee in Turkey, and that so-called was chiefly Indian coffee passing through the Red Sea. The direct supply to the northern parts of Turkey was formerly "English" coffee. The coffee was roasted daily, and powdered more frequently than ground, so as to produce a coarse fracture instead of the fine powder sought for here. The goodness of the coffee in Turkey consisted in its freshness and preparation; there was no chicory or any adulteration. He concurred with Mr. Clifford that it was desirable for India to keep the Turkish markets, and for that purpose they should look after them. They could send through the Suez Canal, and then tranship, which they could afford, as coffee was transhipped at Marseilles and Trieste. The Constantinople market was worth looking after, as the highest qualities could be sold there. It would be well to have the packages made up with Turkish or Persian wrappers or descriptions. The main remedy against the maistri was, as Mr. Clifford said, a knowledge of the native languages, and Englishmen who could not learn in two years should be got

rid of. The maistri would make deductions from the coolies under the manager's eyes. The worst part of the system of frauds was that the coolie did not always get the full wages paid by the employer, and the stimulus of which should bring in recruits. The manager must learn all about feasts, fairs, native superstitions, and lucky and unlucky days. The unlucky days were known all over India, and were to be found in the almanac, and they affected the whole community. European tools were often unsuitable, as hafts were unsuited for small hands, or stout shoes were required which should be supplied with the tools. Combinations of the planters in labour arrangements is essential for the protection of the individual. Mr. Clifford had stated the case well with regard to depressed prices and exchange. The depression of prices is in no degree owing to short supply of gold, but to the effective reduction of the cost of production. So, in the case of Brazil, the rich natural coffee lands were reached by steel railways, made cheaply by the labour-saving inventions of Heath, Bessemer, and Siemens. Thus abundant crops were brought down at a cheaper rate, and in less time than by mules. On reaching the port, the coffee was brought to London at a low freight by the same cheap steel made into the hulls and machinery of the ships. Therefore, the effective cost of producing Brazilian coffee was reduced, and whatever the speculative movements which may from time to time influence the market, he agreed with Mr. Branson that Brazilian crops will govern the market, as constituting the main supply. He considered that Mr. Clifford had well stated the case of the Indian planter under the low price of silver, but he would observe that this recent depression had arrested the rise of wages and commodities, which railway transport had for many years set in operation. Further, the coffee producer was benefited by the lower freights, and thereby he obtained a larger proportion of the market price, which had been reduced, for the freight had to be reckoned off the old price. As to silver, he (Mr. Clarke) had shown that a great reduction had taken place in the cost of producing silver, and that there was no reason the rupee should not go to one shilling or lower. The proposition to re-habilitate silver at a standard was a fallacy; gold was being taken for ornaments now. He (Mr. Clarke) remembered when coffee was consumed in this country, in France, and elsewhere on the Continent. There was no chicory here, and Orater Hunt's roasted corn was sold as roasted corn. Every respectable house had its coffee mill, a higher standard for coffee prevailed, and there were West Indians enough who knew what good coffee was. There was no difficulty in working a trade in genuine coffee. Chicory was grown on the continent, and was introduced during the great Continental war as a substitute for coffee, and an adulterant. It did not seem to strike his friends that their statistics of the importation of coffee did not touch the real state of affairs, nor did they show what was the amount paid by the population for coffee. The statistics need be carried a step further, and it need be calculated out what the people pay on a full coffee price, receiving in return only half coffee, for the average adulteration need be taken at 50 per cent. If the people were supplied with coffee, as they have paid for it, then double the actual amount of coffee would be consumed. When coffee was sold here, the wealthier or working classes never thought of buying bullocks' liver, olive kernels, or any other kind of refuse to mix with it. There was no doctrine of political science, of economics, or political economy, or of free trade, which authorised, or justified, the frauds now committed, or the supply of the population with insufficient, noxious, and deleterious food. The precepts of political science justified and required the punishment of the evil-doers concerned in such nefarious practices. Great light was thrown on the coffee frauds by the recent action of the brewers in promoting the punishment of their fraudulent publicans. The brewers, it may be, cared little for the people, but they cared for themselves; they might not have cared for the consumer being defrauded, but they cared much for the brewer being defrauded. If in a public house belonging to a brewer 20,000 gallons of beer were sold, out of which 5,000 gallons represented water, then the publican would get money for 20,000 gallons, and only pay his brewer for 15,000 gallons. It might be that the more beer was sold (*i.e.*, beer and water), the less beer was brewed by the brewers. A true state may be that the grocers are selling more coffee, *i.e.*, coffee and bullocks' liver, and yet the importation of coffee appears to decline. This must be so, because the decrease in the quantity of coffee imported is not equal to the progress of adulteration. The grocer who adulterates to 30 per cent. displaces that per-centage of coffee, the adulterator of 60 per cent. displaces 60, and the bold operator who supplies 90 per cent. of bullocks' liver, chicory, &c., displaces 90 per cent. of coffee. The lesson from Mr. Clifford's paper was for the grocer and the trade to take firm action, and to try back.

Mr. Martin Wood had been much interested in the paper, and was particularly pleased with the way in which Mr. Clifford dealt with two questions, first, the coolies, whose peculiar habits and failings were no doubt prominent enough, but, as pointed out, if these were duly considered they made good labourers; second, that of the land tenures granted to the planters, which, it was admitted, are fairly liberal. He should like to know what was the kind of coffee chiefly grown in India. He had been told that Jamaica coffee was used as seed in Ceylon, and from that the so-called plantation coffee was taken, though various names were given to it in India. Perhaps Mr. Clifford could say whence these names were derived, and which kind proved most satisfactory. It had been said that coffee would not thrive under 2,000 ft. above the sea level, and

perhaps that might account for the failure of some attempts which had been made. He remembered on one occasion that efforts were made in the Goa territory to cultivate coffee, but believed they failed. Most people would agree with the remarks which had been made about adulteration, but it must be remembered that chicory was no more harmful than water in beer. There were ample provisions in law for dealing with the admixture of noxious or deleterious substances even in coffee; it only required a little more attention to ferret out such abominable nuisances.

Mr. CLIFFORD, in reply, said there was a theory current in Mysore that good coffee could not be grown at a less altitude than 3,000 feet above sea-level, and that was about the height at which his estates lay; but it was grown at a considerably greater altitude than that in other parts. The peculiarity was that the higher you got the better was the quality of the coffee, but the smaller the crop. He held it was a mistake to suppose that coffee could not be grown except at that altitude, but whether it could to commercial advantage he could not say. As to the origin of coffee, it was generally conceded that the beans were first brought from Arabia, which was the true home of the shrub; that they were first taken to Ceylon, and thence to Mysore It was said that coffee was first grown in Ceylon for the sake of the blossoms, which were very beautiful and fragrant, and were used for the decoration of the temples. The plant flourished in Mysore, and some of the finest coffee in the world was now from there; in fact, he could scarcely venture to quote the price of some of the exceptional brands. Those who did not possess these rare kinds did not quite understand it, and looked with some envy on the enormous prices they fetched in Mincing-lane. He thought Mr. Branson was somewhat in error in saying that Brazilian coffee would always rule the price of Indian. So far as Indian, Jamaica, and Ceylon coffee were concerned, he thought they would always fetch a good price in the English market, because it was of a quality which Brazil could not, or at any rate did not, produce. The English consumers would always have the best coffee, and, fortunately, India supplied the best brands. The recent depression had hardly been felt by the best coffee; even at the worst period it maintained its price. He hoped that was an augury for the future, and that Indian coffee would also command the market in England, where people would have the best quality of everything. He agreed with Mr. Branson that a good deal of blame for bad coffee lay at the door of the consumer, who would not even take the trouble to ask for pure coffee. Under the "Adulteration of Food and Drugs Act," if a person asked for coffee. the grocer was bound to supply it, or if he sold him a mixture, to tell him of it, or to point to the label. Unfortunately, the existing law opened the door to fraud, because in poor neighbourhoods there was no guarantee that pure coffee would be supplied even if it were asked for; they knew that this kind of fraud was habitual, and that not one case in a hundred was ever brought home. The consumption of coffee was appreciably hindered by the adulteration which took place, and the taste for coffee suffered because what was supplied was an inferior article, adulterated to the extent of perhaps 50, 60, or 70 per cent. Under such a system coffee never could have a fair field, which all producers and importers, as well as all true friends of temperance, had great cause to complain of.

Mr. BRANSON said he did not intend to convey the impression that the price of fine East India coffee depended upon that of Brazil, but that the price of Brazil had a considerable effect on the whole market. Thus there was a rise of 20s. a ton in East India some time ago simply because Brazil had gone up.

The CHAIRMAN said—It has been a great pleasure to me to preside on this occasion, and we must all feel greatly indebted, I am sure, to Mr. Clifford for the very interesting paper he has just read to us. He has not only given us a mass of information, but has put forward facts which cannot fail to be of great value to persons who have already invested capital, or who are thinking of investing it, in coffee planting. Mr. Clifford's paper has been peculiarly interesting to me, because although I have never had any direct interest in coffee plantations myself, I have watched coffee planting, as I have forestry, in India from its very birth, and have seen a great deal of the growth and development of the industry in Southern India, and have had a wide acquaintance among planters. The only plantations I have ever had to do with personally were teak belonging to the State, and they lay among the coffee tracts. It is just forty years since the Madras Government did me the honour of entrusting me with the organisation of the first scheme of forest conservancy for India, and my avocations then led me through all the districts about which Mr. Clifford has just told us. In those days (I am speaking of about 1848) a few energetic men whose names are well remembered in Southern India—Ouchterlony, Staines, Godfrey, Cannan, Green, and a few others—were struggling with the difficulties which usually beset pioneers, and the whole length of the Western Ghats, from North Canara to Cape Comorin, could only show a few tiny clearings for coffee. Throughout North Mysore, Munzerabad, Coorg, Wynaad, the slopes of the Nilghiris and Annamullays, Cochin, Travancore, Tinnevelly, and Madura, the coffee planter, if heard of at all, was looked on as a speculative man who was risking his money and his health in a very dubious undertaking. Forty years have seen a vast change. All through the provinces I have just named, the planting community has grown into a large and recognised body. They have their beautiful estates, comfortable houses, churches, dispensaries,

clubs, social gatherings, race and polo meetings, &c., and are, in most instances, not only making a living, but turning their forest land into valuable property. They have brought an immense amount of capital and European energy into India, and have effected great changes for the better among the people around them. The presence of such men in the country cannot but be a material strength to the State. The Government on their part have not been slow to recognise the importance and value of the planting community. Much has been done for them, although naturally they ask for more. They now work with secure land tenures and good police protection. Many hundreds of miles of roads and passes have been made by which their crops go to the sea-coast or to the railways. Laws have been enacted in their interests, and under certain wholesome restrictions forest land is made easily available for planting, wherever the Government can spare it. Under such circumstances the coffee industry has, as you have just heard, made great progress—it has its ups and downs of course—but I think we all heartily wish it increased success, and this will certainly be aided by publicity, and the circulation of such valuable papers as that which we have just heard read. It only remains for me to ask you for a cordial vote of thanks to Mr. Clifford for it.

The vote of thans was carried unanimously.

Miscellaneous.

CLOCK-MAKING IN THE BLACK FOREST.

Consul Ballow, of Kehl, says that it is shown by reliable data that the manufacture of wooden ware, such as turners' and coopers' articles, was carried on largely in the time of the Emperor Rodolphus of Hapsburg. Afterwards the making of tin spoons, brushes, and other wares began. Towards the end of the 17th century, farmers who were unable to maintain their families by the products of their farms, began to engage in clock-making. Poor cottagers without property, but with inventive genius, and dependent upon the labour of their hands, were the first clock-makers, and their sons and apprentices introduced this industry into the districts where to-day it is a flourishing business. The case and movements of these clocks were made with tools of the very plainest description, such as a pair of compasses, a small scroll saw, augers, and a knife. These wooden clocks proved to be a fortunate invention, as they found a ready sale and awakened the artistic talent of their inventors. In the middle of the last century clock-making in the Black Forest was already carried on in all the localities where it now exists. The construction of a wooden clock with heavy weights was very plain. It consisted of three wheels only, a vertical swing wheel put into motion, a balance resembling a yoke, to which were attached several leaden weights, in order to regulate the movement of the clock. This method of construction was, however, abandoned in 1740, and it was supplanted by the pendulum clock. At first the pendulum was placed before the dial; afterwards a longer pendulum was arranged behind the movement. All these clocks had to be wound up every twenty-four hours. Some of them were made to strike every quarter of an hour; clocks also were made with automatic figures, such as peasants or soldiers, that sounded a gong at the end of every hour, and also clocks that recorded the months and days as well as the hours. About the year 1750, movements made of wire were adopted, instead of wood, and afterwards metallic wheels were introduced. Since the year 1750, very neat, small clocks, with weights, called *Jockele-Uhren*, after their inventor, Jacob Herbstreit, have been manufactured. At the beginning of this century, clock-making had become a very important industry, and bronght large profits to the manufacturers. From 1830 to 1850, however, this industry did not prosper, owing to the preservation of old shapes, and the manufacture of clocks of inferior quality. With a view of stopping this decline, a technical school for clock-makers was founded at Furtwangen, the centre of the clock industry, in 1850, under the direction of M. Gerwig, who afterwards became one of the constructors of the St. Gothard railway. Its purpose was to educate persons in the making of clocks, and also to introduce the manufacture of watches. The latter project had to be abandoned, owing to foreign competition, but in other respects the influence of the school was soon felt, for since that time the manufacture of clocks has greatly improved. After the expiration of twelve years, when its mission was considered to be accomplished, the school was dissolved, but professional schools have since been founded in the principal localities of the Black Forest, in order to give the necessary technical knowledge to apprentices. Prominent manufacturers also organise exhibitions, showing the condition of clock-making, and the progress made therein. Although modern clocks, of a superior description, are principally made, there are still establishments which produce the traditional old-fashioned clocks, such as were made 150 years ago, with primitive wheels and plain wooden dials. Consul Ballow says that this is less due to the adherence of the Black Forest inhabitants to old tradition than to the fact that these clocks are in great demand, owing to their durability. At one period, the clock-maker made everything belonging to a wooden clock, but the rapidly increasing sales soon rendered a division of work necessary. Owing to the increasing demand, it became necessary to divide the various branches of the clock industry, but the latter still retained the character of a house industry, as the workmen are not employed in factories. They are usually small farmers, having a small extent of land and some cattle, and their spare time is devoted to making parts of clocks. The division

of labour for a Black Forest clock is as follows:—The wood cutter, who prepares the wood of beech trees for the case; the case maker; the maker of the plate or shield; the painter; the founder of the bell and wheels; the chain maker; the spring maker; the carver; the dial maker; the decorator of the case; and, finally, the maker of the primitive movement. In the Black Forest there are, at present, 92 communities engaged in this industry, with 1,429 independent clock-makers, giving employment to 7,526 operatives. In 1796, the workshops turned out 75,000 clocks; in 1808, 200,000; and in 1880, the total production exceeded 1,800,000. In the city of Furtwangen alone, over 400,000 clocks were manufactured in 1880. Black Forest clocks are now exported to all parts of the globe. Every description, from the finest regulators to the plainest wooden clocks, are taken by Germany, while Austria only buys cheap articles, such as chain-work clocks, owing to the very heavy import duty with which clocks are burdened. Switzerland takes the trumpeter and cuckoo clocks for the use of foreigners, and drag-spring clocks for the native population. France bought no clocks for several years after the Franco-German war, but at present large quantities of the carved clocks called "Schottuhren" are exported to that country. Belgium and Holland require wooden clocks with bronze frames. Russia imports a large number of carved regulators, also eight-day clocks in polished cases, for use on Russian farms. Spain and Portugal buy bronzed-framed carved clocks, with weights, and the United States take trumpeter and cuckoo clocks, with painted dials, also regulators and musical clocks.

Correspondence.

THE PURITY OF BEER.

Mr. Stopes accuses me of having committed "a very grave error relating to the quantities of sugar used in brewing." If, as I might reasonably do, I left such a charge wholly unanswered, my silence might be deemed to constitute disrespect towards your Society, or aquiescence in the statement that I had really committed the error in question. I must, therefore, ask you to permit me to go fully into the matter, which is one of great importance to the agricultural interest. I should not have ventured to make use of figures in a paper read before your Society without having previously satisfied myself as to their accuracy.

Mr. Stopes seeks to limit my reply to a consideration of figures ranging over the five years reckoned from March 31st, 1879, to March 31st, 1883. I will not lose sight of his desire to confine the discussion within the narrowest possible compass; but I have not the slightest intention of accepting an invitation which would preclude me from using statistics which he is well aware have a most vital bearing on the case.

In the paper read before your Society, I stated that since the repeal of the Malt Tax there had been an increase of 18 per cent. in the quantity of sugar used in brewing. The Malt Tax was repealed 30th September, 1880, and we have now before the country official figures up to 31st December, 1886. It will thus be seen that Mr. Stopes wishes to give me a limit of two and a-half years only wherein to make my deductions, whereas the period that has actually elapsed since the repeal of the Malt Tax amounts to no less than six years and a quarter.

Mr. Stopes omits to state why he fixes the limit at the year 1883. A perusal of the figures printed in the report quoted by him will, however, supply the deficiency, and will, moreover, throw much light upon the manner in which, I am of opinion, he has contrived to make patient figures belie their own existence.

In a letter addressed to the *Mark-lane Express*, and subsequently printed and circulated in pamphlet form, Mr. Stopes states:—"It is important to remember that rice displaces sugar, not malt. The use of rice permitting English malt to be brewed, the quantity of sugar used in brewing ceased to increase directly the Malt Tax was repealed."

It is obvious that, could the assertion of the decrease be maintained, the farmers would be wholly deprived of what, upon a most superficial glance, appears to be a very plausible argument in favour of the Pure Beer Bills. But there is no necessity to submit figures to any contortional process in order to make a case against these ill-conceived measures. Too many honest facts are available to render such advocacy desirable, or in the least degree necessary. I believe that the use of sugar in brewing has increased since the repeal of the Malt Tax, and being impressed with that conviction I felt it my duty to make this statement to your Society. It has not, however, increased because brewers have used more sugar per quarter of malt. It is rather because the new Act has extended the facilities for the use of sugar by the brewer, and in consequence it is used by a larger number of brewers than was formerly the case. This is the reason of the increase, and none should be better acquainted with the fact than those interested in the preparation of malt adjuncts.

And now for figures. Mr. Stopes asks, "why so wide a difference exists between the official figures and those used by me?" Let us see what that difference actually amounts to, premising that those quoted by me were obtained direct from the authorities at Somerset-house. Comparing them with those given in the Twenty-eighth Report of the Commissioners of Inland Revenue, p. 150, and with those obtainable from other sources, we obtain the following results:—

For 10 Years ended	Totals.	Authorities.
March 31, 1885........	540,354 tons.	Inland Revenue Report, p. 150.
Sept. 30, 1885	550,743 ,,	4 years Parliamentary Returns = 235,207 tons. 1 year compiled from *Brewers' Journal* = 57,087 tons. 5 years Somerset House Memoranda = 258,449 tons.
Dec. 31, 1885	555,838 ,,	9 years compiled from *Brewers' Journal* = 499,838 tons. 1 year missing, and therefore taken from Somerset-house Memorandum = 56,000 tons.
Mean of above	548,978 ,,	Difference = 0·49 per cent.
Stated by me for 10 years, 1876-85	551,725 ,,	

In view of the fact that these figures were obtained by independent compilations, and that my figures were given at a time when opportunity had been afforded for official revision, I think it will be admitted that the statement of Mr. Stopes in this respect must have been made in undue haste, or in ignorance of the facts as they actually exist.

And now with respect to my statement that the use of sugar had increased to the extent of 18 per cent. since the repeal of the malt tax. I can prove my position independently of the figures quoted in my paper read before your Society, and the same proof is open to Mr. Stopes, if he will consult the official returns moved for by members of the House of Commons, and published by Messrs. Eyre and Spottiswoode, setting forth the proportion of malt to sugar used in brewing since the repeal of the malt tax. These returns offer the following remarkable confirmation of my statement :—

	Bushels of malt to every cwt. of sugar.
1881	No figures procurable
1882	46·09
1883	45·60
1884	45·87
1885	40·71
1886	38·83

The difference between 46·09 and 38·83 will be found to amount to 15·8 per cent. Now these returns refer to the whole of the United Kingdom, and it is well-known that in Ireland and Scotland only a fractional proportion of sugar is employed for the purposes of the brewer. Taking due account of this, I think it will be conceded that my increase of 18 per cent. is fully accounted for.

As nearly as I can make out, Mr. Stopes has based his calculations upon the figures for the years ending March 31st, the end of the financial year. Now, as the present tax was levied on and from October 1st, 1880, the figures relied on by him as representing the sugar used in the year 1881, are really applicable to only six months of that year, *plus* six months of the preceding and last year of the old system. It will, therefore, be apparent that calculations with respect to increase, based upon such data, are misleading and fallacious.

I freely admit the value of Mr. Stopes's forensic labours in connection with the opposition to the Pure Beer Bills, but I am not surprised that he cannot reconcile my deductions with his own. What does, however, surprise me, is that he should have limited his attack to my quoted statistics. Why did he not traverse my statements concerning the chemistry of the subject? Surely we are sufficiently at variance upon that ground. He speaks of the nitrogen of malt with the familiarity of an old friend; but, in all conscience, he has formed a curious conception of its properties, if one may judge by his printed statements bearing on the question. Why is he silent on this point?

ALFRED GORDON SALAMON.

1, Fenchurch-avenue, E.C.

THE APPLICATION OF GEMS TO THE ART OF THE GOLDSMITH.

In answer to Mr. Alfred Phillips, Mr. E. W. Streeter writes that "£1,000 a year," in his letter (see *ante* page 499), is a misprint for "£4,000 a year."

General Notes.

TECHNICAL PROGRESS IN RUSSIA.—The manufacturers of St. Petersburg have formulated a proposal for the establishment of a Russian Technical Bureau, divided into various sections, to correspond with the chief branches of industry. The objects of the institution would include the recommendation of technical directors to manufacturers, the examination of reports or communications as to producers' requirements, and the diffusion of information regarding improvements in manufacturing processes.

Journal of the Society of Arts.

No. 1,795. Vol. XXXV.

FRIDAY, APRIL 15, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

COLONIAL AND INDIAN EXHIBITION REPORTS.

The Reports on the Colonial Sections of the Exhibition, prepared under the direction of the Council of the Society, at the request of H.R.H. the Prince of Wales, Executive President of the Exhibition, and President of the Society, are now ready.

The volume, containing over five hundred pages in demy octavo, is published by Messrs. Clowes and Sons, price 10s. 6d. Members of the Society can obtain copies at the reduced price of 8s., by applying to the Secretary.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. Barrett, Mus.Bac., Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing Monday, 23rd May, 1887.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 29; R. Brudenell Carter, F.R.C.S., Member of Council, in the chair.

The paper read was—

COLONIAL WINES.

By Richard Bannister.

The subject of the national supply of foreign wines is one which is both interesting and important. The declared value of our annual consumption of wines is about five millions sterling, consequently, the amount thus expended is of importance to producer, distributor, and consumer, and worth the attention of the different nationalities engaged in viticulture, in order to endeavour to secure the control of our markets. The aggregate expenditure on wine appears for some years past to have varied within fairly narrow limits, but the descriptions of wine consumed have largely varied in quantity, and as the nation has become more temperate, the fashion for heavily fortified wine has diminished, and the light wines of France, Germany, Italy, and our Colonies, have come into more prominent demand. The reduction of the duty on wine containing less than 26 degrees of proof-spirit to one shilling a gallon gave a great impetus to the consumption of French red and white wines, in place of the heavily fortified wines of Spain and Portugal. The port wine of the latter country fell earlier into disfavour than the sherry of Spain, but both have gone down in the estimation of the public—with this difference, however, that there is springing up a demand for port, whilst sherry continues out of favour, as is shown by the clearances for home consumption. For the past year the clearances of Spanish wine reached only a little more than half of what passed into consumption in 1873, but of port the quantity cleared in the same period was three-fourths of the largest amount ever cleared for home use in one year. Of the 13,252,503 gallons of wine on which duty was paid last year, France supplied 5,216,675 gallons, in the proportion of 3,761,395 gallons of red, to 1,455,280 gallons of white; Portugal, 2,883,237 gallons; Spain, 3,611,348; and other countries, 1,541,243 gallons. It will thus be apparent that we are indebted to France for nearly two-fifths of our wine supply, and as the consumption of this wine would, from the Tables given below, seem to be the steadiest and most satisfactory, yet it will be shown presently, that of all the countries supplying us with wine, France has, nationally, been the most unfortunate in viticulture, and that her losses from various causes have been immense. Every year of late her vintages have not supplied sufficient for her own consumption, and she has there-

fore had to draw enormous supplies from other countries, to enable her to supply the demand for "claret" expected to be of native growth, but which is in many instances nothing more than a mixture of thin French wine with stronger wine imported from Spain or Italy. The causes of the falling off in the vintages are bad seasons and the ravages of the phylloxera, and the fact remains that at the present time France has to import largely for her own national requirements, quite apart from what she sends to foreign markets.

The French Commissioners of Indirect Taxes, in their annual report for the year 1886, have dwelt fully on the wine industry, and the following Tables, which appeared in *The Times*, will show in a striking manner the serious depression in that industry, and the straits to which the growers and distributors of wine are put to keep up their supplies.

TABLE I.

Showing the Acreage in Vineyard, Yield in Gallons, Imports and Exports in Gallons, in the Years given below :—

Year.	Acreage in Vineyard.	Yield in Gallons.	Imports in Gallons.	Exports in Gallons.
1875	5,550,000	1,820,000,000	6,000,000	81,767,000
1876	5,430,000	941,551,850	14,700,000	72,200,000
1877	5,360,000	1,260,000,000	14,210,600	67,200,000
1878	5,230,000	1,080,000,000	32,500,000	56,340,000
1879	5,116,000	579,844,000	61,475,000	68,915,000
1880	5,017,000	667,744,120	172,405,000	53,720,000
1881	5,003,000	768,121,065	176,055,000	58,147,000
1882	5,001,000	694,942,920	174,814,000	61,910,000
1883	4,999,000	810,656,595	193,000,000	62,174,000
1884	4,967,000	782,560,000	157,500,000	61,000,000
1885	4,970,000	642,063,000	182,587,000	55,575,000
1886	4,897,755	553,923,000	212,355,000	53,752,000

This is equivalent to saying that, whereas eleven years ago the imports were only 1-15th part of the exports, they are now just four times as great; or, to put it in another way, France, which in 1875 exported more than fifteen bottles of wine to every one she imported, now imports four to every one she exports, and that from the year 1880 the country has to a large extent been dependent upon others for much of the wine consumed in France alone. From experience, I am perfectly aware that during the period named the greater part of the low-priced claret consumed in this country has contained Spanish red or other full wine, for on keeping threw a crust like port, and deteriorated rather than improved in bottle, which is not the case with even poor claret.

But of the wine actually made, the same Commissioners have to state that, in ten months of the year, wine growers used 27,410 tons of sugar to increase the saccharine matter in the wine, and thus by fermentation to raise its alcoholic strength. The picture thus drawn by friendly hands is most gloomy, and it must be obvious that, if there be not a change for the better, the falling off in the vintage, and the importation of foreign wine to supply the deficiency, must, at no distant date, accomplish the ruin of the vineyard proprietors in the affected districts.

It is pointed out in the report referred to, that the vintage of 1875 was exceptionally good, but the averages of the past fifteen years will show the serious falling off alluded to in a more practical light, and demonstrate that the decrease in quantity is not confined to one or two years, but extends over a very lengthened period.

Average produce for the five years.

From 1872-1876	1,236,753,770	gallons
1877-1881	835,202,425	,,
1882-1886	698,790,875	,,

In the midst of such gloom it must be satisfactory to know that France is still at the head of the wine-producing countries of the world, as the following figures will show :—

Country.	Mean Production of last Five Years.
France	698,790,875 gallons.
Italy	564,805,620 ,,
Spain	495,000,000 ,,
Austria-Hungary ..	425,000,000 ,,
Portugal	90,000,000 ,,
German Empire	83,025,000 ,,
Russia	78,750,000 ,,
Turkey in Europe ..	58,500,000 ,,
Greece	29,250,000 ,,
Switzerland	29,250,000 ,,
Roumania	15,750,000 ,,
Servia	12,500,000 ,,

But however high France may stand as a wine-producing country, it is evident that countries like ours, which have to import all wines for their own consumption, will not always be satisfied to import wines from Bordeaux and Rouen which have been there blended with wines not French, and prepared for the foreign markets; but will look to the country of production for their

supplies, and endeavour to procure unmixed wines in every way suitable for their requirements. The skill expended at the large centres named for securing uniformity of quality is special, and not generally known, but if it were, there would be no difficulty for Italy to become a prominent wine-exporting country for direct consumption, as she possesses the quantity and quality of wine necessary for securing a large portion of our trade. It would be worth while for some of the large Italian vineyard proprietors to band together, as was *theoretically* done at the International Health Exhibition, to produce types of wine suitable for this market, and which could be repeated whenever required. But a theoretical unity will not accomplish the desired end, and it will be necessary for such a combination to work on practical lines, before Italian, or any other wine, can to any extent take the place of the wine presented to us as of French growth, but which may, at the same time, be largely composed of the wine of other nationalities, including Italian. The perfection of Bordeaux blending has been only arrived at by patient labour, and the ripened experience of many years' experiments and observations, and what has been there accomplished can, with the same care, skill, and energy, be accomplished elsewhere by the same means.

It has been said that the Phœnicians brought the vine from Asia into Greece, and then from Greece into France, and that in the reign of the Emperor Domitian the vine was largely cultivated in Gaul. It would appear that in consequence the growth of corn was neglected, and the emperor then ordered all vines to be plucked up and no more to be planted. Two centuries afterwards liberty was given to plant the vine again, and from that time to the present it has been carefully cultivated, till now it is the principal source of national wealth; and the long experience thus gained has been of the greatest value and importance. The soil and climate have done much to give the character the wine possesses; and it is only just to say that good claret is the perfection of wine, having clearness of palate, bouquet, and other special characteristics peculiar to itself.

Having now dwelt more particularly on the production of wine in France, it may be of interest to give the two following Tables, which speak for themselves, in showing the quantity of wine imported into Great Britain for home consumption since 1860:—

TABLE II.

An Account showing the Quantity of Wine entered for Home Consumption from France, Spain, Portugal, and Australia, in each year from 1860 to 1870, both inclusive.

Years.	Quantities of Wine entered for Home Consuump-tion from—			
	France.	Spain.	Portugal.	Australia.
	Gallons.	Gallons.	Gallons.	Gallons.
1860	1,125,916	2,975,906	1,776,172	997
1861	2,229,028	4,031,796	2,702,707	8,613
1862	1,901,200	3,955,424	2,350,437	5,440
1863	1,940,193	4,587,180	2,662,611	7,480
1864	2,305,756	4,975,646	2,831,163	8,557
1865	2,611,771	5,192,042	2,889,458	27,223
1866	3,366,073	5,512,125	3,008,784	22,624
1867	3,595,598	5,862,339	2,857,297	18,830
1868	4,502,162	6,182,904	2,853,612	18,622
1869	4,058,674	6,300,973	2,820,976	11,975
1870	4,157,610	6,262,369	2,940,229	29,018

NOTE.—Since the year 1870, the only countries of origin that have been registered on the entry of the wine for home consumption are France, Spain, and Portugal.

TABLE III.

An Account of the Quantity of Wine entered for Home Consumption from France, Spain, and Portugal, and the Quantity imported from Australia in each year from 1871 to 1886, both inclusive.

Years.	Quantity of Wine entered for Home Consumption from			Quantity of wine imported from
	France.	Spain.	Portugal.	Australia.
	Gallons.	Gallons.	Gallons.	Gallons.
1871	4,467,068	6,558,883	3,195,423	31,197
1872	4,773,963	6,925,733	3,298,015	25,084
1873	5,714,436	7,091,514	3,474,369	37,142
1874	5,078,822	6,886,963	3,626,511	40,073
1875	5,039,115	6,776,662	3,887,290	25,243
1876	6,755,419	6,461,340	3,725,396	49,451
1877	6,415,767	6,047,333	3,549,927	19,936
1878	5,852,871	5,557,041	3,248,027	22,871
1879	5,620,054	5,022,776	2,831,498	17,089
1880	6,650,582	4,799,031	2,816,903	24,152
1881	6,584,355	4,663,510	2,785,981	21,287
1882	5,690,944	4,481,316	2,692,509	24,278
1883	5,658,308	4,315,537	2,839,423	69,054
1884	5,610,828	4,099,176	2,860,952	52,746
1885	5,603,721	3,921,608	2,906,367	60,667
1886*	5,216,675	3,611,348	2,883,237	148,404

* Red, 3,761,395; white, 1,455,280.

Total in 1886,	France	5 216,675
	Spain	3,611,348
	Portugal	2,883,237
	Australia	148,404
	Other countries	1,392,839
	Total	13,252,503

At the end of the Table I have purposely repeated the figures before given of the quantities of wine furnished to us by different countries, to fix upon your attention what a comparatively small quantity is obtained from "Other countries," and of this small quantity how very little is received from Australia, or from our other dependencies. However, Rome was not built in a day, and the quantity and quality of French wine have been produced only by the labour of centuries, and it will be my endeavour to bring before you the facts connected with the planting and developing of "John Bull's vineyard," as it has been aptly termed, and then you will, I think, agree with me that the prospects of the success of viticulture, in Australia especially, are most hopeful; and if prosecuted with the same energy and determination as is now shown by those engaged in this interesting branch of agriculture, there is no doubt that the quantity of wine received from our dependencies will be greatly increased, and its quality duly appreciated as it becomes more widely known, and this, too, in a very brief period of time.

The introduction of the vine into Australia is of comparatively modern date, and the credit for this introduction is generally given to Mr. J. MacArthur, and the date 1820. It would appear from the records of this Society, that in 1822 a silver medal was awarded to Mr. Gregory Blaxland, for a quarter-cask of red wine, resembling claret, and in 1828, a gold medal was awarded to the same gentleman, for a superior quality of the same wine. In some official papers sent to the Society, it is shown that Mr. Blaxland was engaged in viticulture in 1816. After diligent search, I can find no trace of Mr. Blaxland's name in the wine bibliography of the Australian Colonies. MacArthur is credited with planting the first Australian vineyard, and his knowledge of vines and their culture was obtained in a somewhat remarkable manner. Owing to a quarrel with the Governor, he was forbidden visiting Sydney from 1811 to 1817, and during his enforced absence, he devoted himself to the education of his sons, and travelled with them on the Continent. His son William, who was destined to act an important part in developing the colony of New South Wales, was placed at school at Vevey, in Switzerland. During his stay there amongst the Swiss vineyards, he not only became possessed of a fair amount of knowledge respecting the cultivation of vines and the manufacture of wine, but he also made friends of men who not only imparted to him the knowledge he sought, but who, in their turn, became interested in the far-off land of MacArthur's birth, the New Holland of those days. A relative of one of these friends subsequently married, and four years afterwards her husband was appointed to an official position at Port Philip. About the year 1840, a dozen or so of practical viticulturists had departed from Switzerland to settle in Australia, and on their arrival they settled down to grow vines, and produce wine on the same principles as prevailed in their native country. In other parts of Australia efforts had been made to cultivate the vine as a branch of industry, but unfortunately for the success of the new venture, the cultivators possessed no special knowledge of the soil required for grape growing, and no experience of what was necessary to manufacture wines which would keep and be appreciated by the wine-drinkers of that day. The ordinary beverage of the colonists was beer rather than wine, and, therefore, the viticulturists had to successfully compete with the wine of foreign manufacture, which experience had proved would command a sale. The first venture was a comparative failure, and consequently an enlightened traveller, named Busby, visited Europe in 1831, and after making himself acquainted with the species of vines cultivated for producing the wines of commerce, the mode of manipulating the grapes when fit for the press, and other matters connected with the successful production of the fashionable wines of that day, he returned home with specimens of the vines he had seen in cultivation, and did what he could to put vine culture on a more satisfactory basis. Without going over all the details of the wine industry from 1831 to a more recent date, it is necessary to note that the progress made was, for a number of years, very satisfactory, and that so long as the demand and supply went hand-in-hand, the growers were able to extend their vineyards, and make a little money on their ventures. But, as it very frequently happens in trade, a desire was fostered and encouraged by men prominent in position in the Colonies to extend viticulture, and to tempt people to place more land under vine cultivation than the circumstances demanded. The Government of that day favoured this scheme, and by legalising a system of obtaining land on very easy terms, which was known as the system of "free selection," the people became infatuated with the prospect of

being landowners, and when the land was taken up much of it was placed under vine cultivation. The mania for planting vineyards, which had been thus unsoundly fostered, was not confined to any particular class, for lawyers, doctors, and amateurs of all sorts were affected, and some who had not the strength of mind to resist, but who had not the opportunity to cultivate the land themselves, did so by deputy. The Press fostered the movement as long as it was popular, and by prizes and other means inducements were held out to vine cultivators, which eventually could only end in disaster. In any circumstances over-production is always to be deprecated, even when the goods so produced are of the best quality, and satisfactory as to pattern and fashion. But, in the case under consideration, both quality and fashion fought against its success. Port, sherry, and the stronger wines being in most prominent demand, the vineyards were generally made in low lying, warm districts. Those who from choice or compulsion selected temperate localities were looked upon either as visionaries or unfortunate men, but as time wore on, and the excitement attendant upon a new venture had subsided, it was first observed that the methods practised to make the strong, typical wines were wrong, the must was not properly fermented, and as a result acid was developed, and the wine was unfit for consumption, either when used alone or when mixed with other wine. Fashion had also changed during the time these experiments had been proceeding, and by the time the vineyards were capable of producing grapes in quantity, the demand for strong wines had fallen off. This error of judgment on the part of the wine growers was a pardonable one, because the change of fashion in favour of light wines had been very sudden, and not contemplated even by those considered most competent to form an opinion. Mr. Scott, her Majesty's Consul at Bordeaux, said, in the year 1854:—

"Very few wines of the last five vintages would find a sale in England, and it is the conviction of all those conversant with the tastes and habits of Englishmen, that the meagre, poor, red wines of the Gironde, known as 'clarets,' would never find a sale there. A reduction of the duty, such as is proposed, to one shilling, would not only produce an immense loss to the Revenue, but, by favouring the admission of these miserable wines, the mass of the consumers would be disgusted, and the result a decided prejudice against clarets."

The strong wines of Spain and Portugal had to give way to claret and other light wines, whose consumption had been fostered in this country by the lowering of the duty on them and by the praises of the Press; consequently, when the highly-alcoholised wines were ready for the market, there were no buyers. It was impossible to make light wines from the vines which had produced the heavy and unsaleable wines, and in these altered conditions of the wine market, planters who had but little capital had to lose all, and those who had capital diverted it as well as they were able into other channels, but this could not be done without considerable loss. The wine, if it had been good in quality, and carefully matured, might have been kept till the public taste again set in the direction of brandied wines, but, unfortunately, scarcely any of the wine would keep, and what with its bad quality, and the change of fashion, Australian wines of all sorts were looked upon with disfavour, and the good as well as the bad were alike shunned. Those who had foolishly embarked their money in the enterprise without knowledge of the business, condemned the wine as the cause of their disasters instead of their own infatuation, and altogether the prospects of the viticulturists were very gloomy indeed. But, fortunately for the revival of this industry, the produce of some of the vineyards, situated in cool positions, had been carefully supervised by experienced persons, the grapes had been pressed and fermented on properly defined principles, the wine had been carefully matured, and, when compared with what was in demand for consumption, the quality, flavour, and price, of this home-manufactured wine offered such inducements to the wine merchant that his prejudice was overcome, and he saw that the ruin which had overtaken so many was due to errors of judgment, rather than to natural causes. The light wines came into more general demand, and those who had vineyards planted with proper grapes made the light wines, and those who had not started again, and did what they could to retrieve their past errors, by falling in with what not only was to the public taste, but which wine had also, by its keeping qualities, been proved to have been made on true scientific principles. At this period, when an effort was being made to produce wines appreciated by the public, exhibitions of native produce were held at Adelaide and Melbourne, and, as a matter of course, wines of all descriptions were largely represented. Amongst

the prizes to be competed for at the former place, was one offered by the then mayor of Adelaide "to the exhibitor who shall, by his exhibit, show that he has done most to promote an industry or industries of national importance, and likely to be a source of wealth to the Australian Colonies," and another valued at £800 was offered at Melbourne "to an exhibitor in one of the Australian Colonies, as an acknowledgment of the efforts in promoting art and industry, as shown by the high qualities of the goods manufactured by such exhibitor." The mayor of Adelaide's prize fell to Mr. Thomas Hardy, the Bankside vineyard in Adelaide, "in recognition of successful individual enterprise of much magnitude in various industries, as illustrated by his exhibit." The award seems to have been well deserved, for it was notorious that Mr. Hardy had done much in promoting new industries, and in carrying old ones to success.

The Melbourne prize of £800 was supplied by the Emperor of Germany, who has for many years past proved in various ways that he is keenly alive to any movement that may tend to improve the commercial advancement of Germany. He not only offered the prize named, but took an active part in sending over German goods for exhibition, with a staff of assistants under the direction of Professor Reuleaux. Offered under the above-named conditions, the prize fostered a display of keenest emulation. Fifteen jurors recommended an equal number of competitors, each of whom had been selected as the best representative of the principal colonial industries; Professor Reuleaux was then left to make the ultimate award. This task was of extreme difficulty, and the learned professor was at one time so despondent of his own ability to come to a proper judgment, that he said, "He felt it a most difficult task to decide between the competing claims, and he had almost made up his mind not to attempt it, but to hand the prize over to the public library with the names of the fifteen competitors inscribed thereon." The importance of the wine industry of Australia, however, enabled him to arrive at what would be a safe decision. The cultivation of the grape had been of great benefit to Germany, and he had no doubt would become equally valuable here. The Australian wine possessed many important qualities. If he awarded the prize to Messrs. de Castella and Rowan, who were recommended by the wine jury, he was sure it would be recognised as a proof of the disinterestedness of Germany, for the colonial "*vignerons*" promised to become formidable competitors of the German wine growers. The prize was then formally awarded to the proprietors of the St. Hubert's vineyards. Strangely enough, the senior partner of the firm was one who in 1854 had emigrated from Switzerland, and whose view of the proper wine to be considered the standard *par excellence* differed from most of the wine producers of that day. His type of wine was one of extreme delicacy of colour, flavour, and bouquet; the white must be almost free from colour; the red must have a rich colour and to be not too stout; and both white and red to be thoroughly fermented. He had to wait long for the verdict eventually given in favour of his judgment and discrimination, but at last it was given with no unsparing hand, and those exhibitors who had run the victor very closely in the race, and were defeated more on account of the quantity than the quality of their exhibits, were thus assured that the demand for heavy wines was gone, and that, to make headway in wine production, they must follow still more closely than they had done all the conditions necessary for securing colour, flavour, lightness, and such elegance as would please the eye, smell, and taste. Such an appreciation of light wines was not lost on the viticulturists throughout Australia, and from that day to the present the production of heavy wines has diminished, and those of the port, sherry, and Madeira type have gone quite out of favour. It is proper to state here that out of the wines exhibited in the Health Exhibition of 1884 and in the Colonial Exhibition of 1886, there were very few samples of these wines which compared at all favourably with those produced in Portugal, Spain, and Madeira. The wines were different, and, through possessing distinctive qualities, they did not admit of a comparison being made. This remark applies especially to the Madeira samples. The special characteristic of ordinary commercial Madeira is that it tastes as if it had been partly boiled, or at all events had been heated to a high temperature, and this character and flavour no doubt are imparted by the ordinary process of keeping the poor wine for a certain period at a temperature of about 130° Fahr., and the better quality at a temperature not exceeding 90° Fahr. In passing, it is interesting to note how history repeats itself. This practice of heating wine has been in operation in Madeira for at least 100 years, but when the process was applied to beer, a few years ago, it was considered an original discovery, and looked upon as one of

the greatest of novelties. There is no doubt that it imparts soundness to wine and beer so treated, by destroying certain hurtful ferments, but no one will speak much in favour of the peculiarity developed by the treatment, as the freshness of flavour is thereby very greatly modified, and in some cases destroyed. The almost complete elimination of the heavy wines from the produce of the Australian Colonies deserves to be specially recorded, because the attention of viticulturists has been in consequence more fully directed to the production and growth of wine suitable for the European markets. With the object of testing the fitness of the wines for competing with those of French growths, no less than eighty-nine exhibitors from the Australian Colonies took part in the Bordeaux Exhibition of 1882. The reasons for sending the samples were, that as the resources of these colonies for viticulture were practically unlimited, if a minimum price could be fixed on the wines sent sufficiently remunerative to justify an enlarged production, the dealers in them in France might be assured that, in a few years, their requirements would be met, however great they might be. The results of the competition were highly satisfactory; no less than 16 gold, 28 silver, and 23 bronze medals were awarded, and 21 other exhibits received honourable mention, and the quality of the wines was such, that a number of the samples were considered better than any other imported wines, and also competed favourably with many French wines of ordinary growths, which enter largely into ordinary consumption. Special, but not undue stress was laid on the necessity of the colonial wine growers ascertaining the vine species best adapted to their land, the methods of cultivating soil, the best suited to local exigencies, to the climate, the frequency or paucity of the rain, and the perfecting of their implements. By thus taking advantage of the experience of Europe, the end aimed at must be more quickly attained, and though the well-known light wines of Europe may never be obtained, yet a reasonable hope exists for the wines prepared on the most approved systems of cultivation and management to have distinctive characteristics which shall make them specially sought after. These characteristics are already developed in certain wines, and for such there is a growing demand in this country.

Apart from the difficulty of successfully developing a new industry, the viticulturists of Australia have been visited by the two great pests of European vineyards, the oidium and phylloxera. The climate of Australia lends itself very readily for keeping the former under control, but the phylloxera cannot be so easily managed, and when allowed to proceed unchecked, it destroys the vineyards as effectually as the locusts of Cyprus do the crops of that island. It has been computed that the damage done to the vineyards of France by this pest amounts to 800,000,000 sterling, and the most serious matter is, that no effectual remedy is forthcoming which will put an end to its ravages. In Hungary, the vineyards are flooded at a certain season of the year, and in this way the vines are kept free. The same remedy has been applied to one vineyard in France with like results, but as a rule the vineyards on the Continent and in the Colonies are so situated on high ground that it would be impossible to flood them. In France, some of the vineyards have been replanted with American stock vines, which, from experiments made, are supposed to be able to resist insect attacks, and afterwards the vine of the district is grafted on to them. All efforts made, however, in France up to the present time to eradicate the phylloxera have proved a failure, and every year vineyards are passing out of cultivation in consequence. In Australia the vineyards near Geelong were first attacked, and there is no doubt that the phylloxera was imported with European vines.

The life history of the insect has been studied as closely as circumstances will allow, but there are so many differences of opinion on this point entertained by different workers in this field of research, that it is almost impossible to work out an intelligent description of the habits of the insect. The following, however, seems to be what occurs. The insect, which is very small, undergoes at least three distinct changes in its life history, and sometimes five. Those insects which undergo five transformations possess wings, and at the proper time are able to fly a distance of some miles, which they do in swarms. These flights take place about the month of August, and as the insects invariably settle on vines, they must have sight and smell fairly well developed. The phylloxera with wings are females, and soon after their flight, when in repose, they lay eggs of two sizes, the larger producing females and the smaller males. In about three weeks the insects are fully grown, when they at once pair, and shortly afterwards one egg (the

winter egg) is laid, generally in a deep depression of the stem. The parents die, and the egg remains in position till about April or May, when it is hatched. The young insect is a female, and when possessing strength enough she travels down the stem of the vine into the ground. She then fixes herself to the vine roots by inserting her proboscis, and then in the puncture she lays a number of eggs and dies. The young from these eggs are all females, and they lay eggs and die like their parent. This operation is repeated in periods of different lengths, which are more or less regulated by the temperature; and in the course of a very short time millions of phylloxera are produced from one pair only. Some of the insects do not enter the ground, but remain on the plant, and after passing through certain changes they appear with wings as first described. From what has been said it is evident that if the flying insects could be destroyed, the mischief might be kept within the present bounds, or if the winter egg could be crushed, the same result would follow. But close observation of this kind would require patience, diligence, and perseverance, and the expense which would be incurred in this abour of extermination has, up to the present time, deterred the wine grower from making this general war on the pest of the vineyard.

In Australia, the regulations for destroying the phylloxera are of the most searching kind, and perhaps these regulations as given in the Victoria Blue-book may be worth making a part of this paper. They were prepared by Mr. D. Martin, the Secretary for Agriculture:—

"The vine disease caused by the insect known as *Phylloxera vastatrix* was discovered in the vineyards at Fyansford, three miles from Geelong, in the year 1877. It is now ascertained to have been present in this district for years before it was recognised as the dreaded phylloxera—probably for about ten years—and its origin was doubtless the importation of diseased plants.

"In order to prevent, if possible, the disease from spreading, an Act was passed providing for the appointment of inspectors of vineyards, with power to enter any lands whereon vines were growing, for the purpose of ascertaining whether the vines were infected, in which case the fact was to be reported to the Chief Secretary, who might authorise steps to be taken to eradicate the disease, either by destroying the vines, or otherwise, no compensation being granted to the owner of the vines for any loss he might sustain in consequence of such measures. In 1878, thirteen vineyards, containing an area of 75 acres, were uprooted, and the vines burnt; and in 1879, six vineyards, containing an area of 35 acres, were similarly treated.

"In November, 1880, a Select Committee of the Legislative Assembly was appointed to inquire into the state of the disease, and the best means of eradicating or mitigating it. The committee reported that there was no evidence to show that the insect settled on any vegetation other than vines; that so far as experiments had been tried no remedy or cure for the disease was known; that the time most to be dreaded for the spread of the disease was about the end of December; and that there was no other cure than the entire eradication of the vines. It was recommended that a cordon, having a radius of 20 miles, should be drawn round Geelong, and that no part of the vines within that cordon, whether cuttings, leaves, fruit, or roots, should be removed outside of it; that all vines within that cordon should be inspected, and all reported as diseased, or growing within a three-mile radius of any reported as diseased, should be uprooted and burnt, the owners being awarded a moderate compensation, based, not upon the value of the vines, but upon the estimated value of the crops for the ensuing three years. Consequently upon this report another Act was passed, repealing all former Acts relating to vines and vineyards, and providing for the proclamation of infected localities as 'Vine Disease Districts,' to which inspectors should be appointed, on the receipt of whose reports the Minister might order any diseased vines to be uprooted, as well as all other vines, whether diseased or not, within a radius of three miles thereof, compensation being given to the owners of diseased vines up to the value of one year's crop, and to owners of vines not diseased up to the value of three years' crops. Persons were prohibited, under a penalty not exceeding £100, or imprisonment for any term not exceeding six months, from removing from a 'Vine Disease District' any vine or part of a vine. The Governor in Council was also granted power to restrict the importation of vines, vine cuttings, or grapes, and to make regulations for the pnrpose of carrying the Act into effect. The question, moreover, formed one of the subjects of discussion at the Intercolonial Conference held in Melbourne in December, 1880, when it was agreed by the colonies of New South Wales, South Australia, and Victoria, to contribute jointly to the expense of eradicating the disease.

"'The Phylloxera Vine Disease Act,' 1880, was amended towards the close of 1881 by the 'Geelong District Vine Disease Act,' 1881, 45 Vict. No. 718 (24th December, 1881), which gave power to the Minister to order the destruction of all vines growing within the boundaries of the Geelong Vine Disease District, as described in the *Government Gazette* of the 12th January, 1881. Under the powers given by this statute all vines within the proclaimed district have been destroyed, except those in the parishes of Birregurra and Warrion. These parishes are situated at from 24 to 45 miles from where any diseased vines

were growing, and consequently are not likely to be reached by the insect.

"Under the several statutes above-mentioned the vines have been destroyed on about 2,000 separate properties; about half of that number being cottage properties in Geelong and suburbs; and compensation has been awarded in amounts varying from £1,042 to 1s. The disease from first to last was found in 34 properties only, comprising an estimated area of 281 acres. These diseased properties are situated in a district extending from the Leigh Road to Germantown, in the valleys of the Moorabool and Barwon Rivers, a distance of about 16 miles. The last of the diseased vineyards was destroyed in 1882. The phylloxera is, however, not yet extinct. Recent examinations show that the insects are alive in several of the infected properties upon the still succulent rootlets which have been left in the ground. In some properties the roots are decayed all over, and consequently the phylloxera are dead; in the others the roots are decayed over portions of the properties only; the area of succulent roots is yearly becoming less. The proclaimed district is still retained in quarantine, special attention being given to the destruction of any vine shoots or re-growths from imperfect eradication."

Certain wine growers have objected to these regulations on the ground of their stringency, and have not only ridiculed the idea that the phylloxera is as hurtful to the vine as it is said to be, but have even said that it does good rather than harm. Sympathy must be felt for those who suffer from its attacks, but only contempt can be expressed for those ready to dispute the accuracy of the statements made about the harm done by the phylloxera, and for no other purpose than for saving their money. The area of mischief has, by the strict enforcement of the regulations, not extended, and it is anticipated that in a few years the phylloxera will be stamped out in Australia. It was foreseen that the restrictions imposed must produce hardships in certain cases; but, as in the case of our cattle disease regulations, they have done good to the many at the expense of the few.

The Colonial Exhibition has given us an opportunity of seeing Australian wine in bulk as well as in bottle. In the case of the bottled wine, a small proportion of it was badly bottled and packed, while a considerable quantity was in perfect condition, and had been bottled, capsuled, and labelled in the best manner. The casks used were in many cases quite unsuitable for the purpose. Instead of being uniform in size, like the French, German, and other casks containing European wine, they were of all sorts and sizes. Some had previously contained whisky, others brandy, and others sherry, and even port. This unfitness of the casks is mainly due to the fact that all the wood for cask making has to be imported, but France and Spain have to do the same thing, and what can be done in one country can be accomplished in another. Already I have heard of the probable starting of wine cooperages at an early date, and before Australian wine can make much headway here, the casks containing it must be sound and good, capable of bearing the long journey with ease, which is not now the case, and be clean and well seasoned enough not to impart flavour or character to the wine contained in them.

Without individualising any wines as being of special quality, I give, in the following Table, the results of the examination of certain typical wines, and the wines of the claret, hock, and burgundy type will commend themselves to you. The quantity of alcohol they contain makes them admirably fit for consumption here when ordinary French clarets are too cold and thin; and from the experience gained last year it is hoped and expected that that portion of the public who have not taken to claret, hock, and burgundy, on account of their thinness, will be tempted to substitute the heavier white and red wines of Australia for the sherries and ports they now consume.

TABLE IV.

Description.	Specific Gravity.	Per-centage of Proof Spirit.	Extractive.	Fixed Acids calculated as Tartaric.	Volatile Acids, calculated as Acetic.	Ash. Total.	Ash. Insoluble.
Burgundy, '69 ...	990·34	26.5	2·264	·495	·174	·276	·052
Burgundy	090·24	28·6	2·284	·540	·084	·308	·054
Burgundy, full ...	995·55	20·3	2·326	·413	·186	·438	·050
Chablis	991·17	24·5	2·116	·472	·150	·238	·034
Claret	994·08	23·8	2·640	·622	·090	·360	·044
Claret, full	995·60	21·0	2·306	·420	·228	·456	·050
Ruby, No. 1	995·68	21·9	2·436	·510	·132	·390	·060
Cup	991·95	22·5	1·834	·405	·114	·212	·052
Ruby Cup	995·55	28·8	3·646	·472	·156	·324	·064
Hock	991·66	20·3	1·232	·458	·054	·188	·040
Muscatel............	989·93	25·1	1·776	·420	·120	·230	·048
Reisling	991·55	24·9	2·280	·607	·114	·204	·046
Frontignac	1017·46	29·4	8·866	·435	·114	·344	·068
S. A. Port	1006·86	36·0	7·386	·500	·042	·352	·058
Sherry	992·53	34·6	3·686	·570	·060	·246	·044
Shiraz	1026·26	36·1	12·136	·375	·072	·470	·062
Sauterne, dry......	989·18	29·9	2·438	·502	·048	·180	·056

Passing from our Australian Colonies to the Cape of Good Hope, I present you with a Table of facts, which will throw much light on my subsequent remarks respecting the past and present history of wine growing in that colony.

TABLE V.

Showing the quantities of each kind of Wine retained for home consumption, and the revenue received every tenth year, from 1790 *to* 1850.

Year.	Cape.	French.	Portugal.	Madeira.	Of the Azores.	Spanish.	Canary.	Rhenish.	Other sorts.	All sorts.	Revenue.
	Imperial Gallons.										£
1790...	...	618,640	...	...	...	...	...	...	5,982,398	6,601,038	959,565
1800...	...	80,243	...	...	...	...	...	...	7,214,509	7,294,752	2,124,808
1810...	...	212,520	...	...	...	...	...	...	6,308,773	6,521,293	2,785,587
1820...	491,199	164,292	2,361,471	353,492	7,448	935,971	172,741	26,061	73,820	4,586,495	1,987,817
1830...	535,255	308,294	2,869,608	217,138	2,780	2,081,423	101,892	68,322	249,733	6,431,445	1,524,168
1840...	456,773	341,841	2,668,534	112,555	191	2,500,760	29,298	60,056	383,914	6,553,922	1,791,636
1850...	246,132	340,748	2,814,979	70,360	246	2,469,038	15,995	54,668	425,056	6,437,222	1,821,123

Amount of Duty per gallon levied on various Wines, shown every tenth year from 1790 *to* 1860.

Year.	Portugal.	Spain.	Madeira	Teneriffe.	Sicilian.	Cape.	French.	Rhenish.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1790	3 $1\frac{3}{4}$	3 $1\frac{3}{4}$	3 $1\frac{3}{4}$	3 $1\frac{3}{4}$	3 $1\frac{3}{4}$	...	4 10	5 $2\frac{1}{2}$
1800	6 11	6 11	6 11	6 11	8 3	...	10 $6\frac{3}{4}$	9 $0\frac{1}{4}$
1810	9 1	9 1	9 $2\frac{1}{2}$	9 1	9 1	...	13 9	11 3
1820	9 1	9 1	9 $2\frac{1}{2}$	9 1	9 1	3 0	13 9	11 3
1830	4 10	4 10	4 10	4 10	4 10	2 5	7 3	4 10
1840	5 9	5 9	5 9	5 9	5 9	2 11	5 9	5 9
1850	5 9	5 9	5 9	5 9	5 9	2 11	5 9	5 9
1860	3 0	3 0	3 0	3 0	3 0	2 11	3 0	3 0

In 1861, the duty upon all kinds of wines was altered to :—

Containing less proof spirit than 18 degrees... ...	1	0	per gallon.
,, ,, ,, 26 ,, ...	1	9	,,
,, ,, ,, 40 ,, ...	2	5	,,
,, ,, ,, 45 ,, ...	2	11	,,

In April, 1862, it was altered to :—

Containing less proof spirit than 26 ,, ...	1	0	,,
,, ,, ,, 42 ,, ...	2	6	,,
And additional for every degree over 42...	0	3	,,
In bottles containing less than 42 degrees	2	6	,,

In May, 1866, the duty on wine in bottles was made the same as on wine in casks.

This Table shows the source of our wine supply from the year 1790 to 1850, and when read with Tables II. and III. will give the return of wine cleared for consumption from 1790 to the end of last year. It is interesting to note how fashion appears to have changed during this period, and many wine drinkers will scarcely believe that in a period within the last fifty years, considerably less wine was annually imported from France than from our colonial vineyards at the Cape of Good Hope. Nevertheless such is the fact, and this fact is so far encouraging as to show that there is a distinct connection between value and popular taste, and if this connection be carefully studied by colonial viticulturists, they will be encouraged, by an increased sale of their wines, to give such quality and value as will be appreciated

by the wine consumers of this country. The public *en masse* are very good judges of quality, and from an intimate knowledge of this good judgment of the multitude, I am confident that quality will always be appreciated, and whatever may be the origin of supply the best value will generally command the market. The Table I have prepared will illustrate my meaning very well. If we carefully compare the imports from different countries with the ratio of duty imposed, it will be seen that as long as our colonial wines from the Cape were favoured with being charged a lower rate of duty than wines from other countries, so long the consumption of Cape wines was very considerable; but as soon as the duties became more equalised, the consumption of colonial wines gradually diminished, as the difference in value of these wines was not so great as the difference that had been made in the rates of duty. Thus from 1820 the duty charged on French wines was from time to time reduced, and the consumption in consequence materially increased. In 1860, the wine duties were made practically the same; and in 1862 the further change was effected of changing the duty on the alcoholic value of the wine. Both of these changes were against colonial interests, and in favour of French wines, and the effect has been to increase the consumption of French, and almost drive out of the market South African wines. In addition to the loss sustained through the equalisation of duties, the wine growers of the Cape have not been as careful as they ought to have been in manufacturing their wine, nor did they generally send it in as good condition as their Continental competitors; consequently, when the change was made in the scale of duties, the wines, on their way here and in bond, had to be kept on account of diminished consumption, and they were not sound enough to improve by age. The demand for them from one cause or other ceased, and up to the present time the trade has not revived.

It would not be just to pass over thus lightly the Cape wine industry, as the capabilities of South Africa, both as to soil and climate, for producing wines are unique. For more than 200 years the vine has been cultivated, and experience has proved that no country in the world possesses a climate more favourable to the cultivation of the grape than the Western Province of the Colony. A proper combination of sunshine, rain, heat, and humidity during the growing and ripening of the grapes makes the vineyards more prolific than in any other part of the world, and the soil, although slightly deficient in lime, is in all other respects admirably suited for vine cultivation. A bed of ferruginous marl, locally named "Kalkbank," stretches for miles, and as this marl, on exposure, steadily decomposes, it forms a rich, loose, and deep soil. The vineyards on this soil are most productive, and it has been stated by Baron von Babo, a well-known authority on viticulture, that the comparison of production in the following countries may thus be summarised:—

	Hectolitres.
Hungary, 1861-72	24 per hectare.
Germany, ,, ...	24 ,,
Austria, 1874-80	18½ ,,
Switzerland ,, ...	42 ,,
France, 1873-83	18¼ ,,
Italy and Spain, 1873-83	17 & 17¾ ,,
Cape Colony coast districts ..	86½ ,,
,, ,, inland ,, ..	173 ,,

But however productive the soil may be, or however good the grape, both are alike without value if the wine made is deteriorated or spoiled in manufacture. That this has lately been the case is admitted by the wine growers themselves. The unsound grapes have not been removed before the grapes were pressed, the men engaged in the cellars have not been cleanly, and in the cellars themselves different hurtful ferments have been allowed to find a home. In these circumstances it is not surprising that unsound ill-flavoured wines have been produced, and, as a consequence, there has been little demand for them at home or abroad, the quantity exported having fallen from 195,051 gallons in 1865 to 92,065 gallons in 1885. The Cape Government have become alive to the defects in the wine industry, and are well aware of the causes which have contributed to its decay. With praiseworthy determination to improve it, they have purchased the famous Constantia vineyard, and have made it into a school for the study of practical viticulture, under the direction of Baron C. von Babo with two competent assistants. Under his supervision the special characteristics of each description of grape grown are studied and noted, the most scrupulous attention is devoted to the gathering, pressing, and fermentation of the grape, the cellarage arrangements are scientifically conducted, and thus, by care and attention, it is expected that a successful future is yet in store for South African wines. Owing to prejudice against any new methods or novelties, as they are termed, the task to be

accomplished is a difficult one, but it is not hopeless, and in the near future we may perhaps see the Cape wines again rise to the same position they occupied before the equalisation of the wine duties.

In the present condition of the French brandy market, there should be a growing demand for South African brandy. Much of the cheap stuff now on the market is mainly composed of grain spirit, and a grape brandy of even poor quality should be preferred to grain spirit brandy; and with the brandy market in favour of colonial productions an effort should be made to present the public with a pure brandy, comparing favourably in price and quality with the substitutes now sold under the name of brandy.

Canada has of late years embarked in grape growing and wine production. Although the climate is severe, and the physical difficulties to be overcome are great, yet, in the province of Ontario, large quantities of grapes are now grown, and fairly good wine is made from them. At the present time this wine is locally consumed, but certain kinds which were exhibited last year were pleasant and drinkable, and possessed qualities of a distinctive and characteristic kind. At a future time Canada may become a wine exporting colony, but at present she confines herself to raising grapes and making wine for her own use only.

The subject of our colonial wine production, and power of supply, is one that cannot be fully treated in one paper, but sufficient has been said, I trust, to interest you in the development of this industry. Our colonial wine growers, who are in touch with the wine growers of Europe, have shown what progress they can make in a business which, up to the present time, has been beset with difficulties, and our French neighbours have certified in a remarkable manner that a great deal of the wine produced in Australia has quality and character to recommend it. Efforts must be made to supply wines shipped under certain names of the same quality, so that orders can be repeated, and in this connection it is well to remember that it is not the Chateau wines which bring prosperity, but the ordinary wines of good quality which are consumed in large quantities, because they are good and cheap.

The present condition of the French wine trade affords great opportunities for developing and consolidating the supply of wine from our Colonies, and I would recommend the growers and shippers to take a lesson from the Bordeaux claret shippers, and work on those lines which have been attended with such success in the past. No lessons are so good as those which come from experience, and the learning which may be thus imparted to us by the experience of others is always great and valuable, and the proper management and manipulation of wine for our consumption is no exception to the rule.

I beg to acknowledge the valuable assistance I have received from my friends Messrs. Bennett and Cheater in the preparation of this paper.

DISCUSSION.

The CHAIRMAN said he trusted, in spite of the well-intentioned efforts of those gentlemen who subsisted on cold water, that England would long continue to be a nation of wine consumers on a liberal scale, for he was quite certain that the moderate consumption of alcohol, for the great majority of the human race, in such a climate as this, was fraught with many advantages, and kept one in the best possible working condition. Looking at the precise state of this great question—great, not only as regarded our personal requirements, but also as an actual, and still more as a prospective, bond of union between the mother country and those great countries beyond the sea, which we were proud to own as common subjects of the Queen—the question of the wine supply was one of vast importance. If we compared the colonial supply now with what it used to be, especially with the 997 gallons which came from Australia in the first year, there was great ground for congratulation. He knew a cloth manufacturer who once bought, for consumption in his own mill, the whole of the first Australian shipment of wool. That had now become one of the most gigantic industries of the world. It would have been quite possible for one wine merchant to have bought all those 997 gallons, and they might equally look forward to a proportionate increase in the wine produced by the Colonies. His earliest recollection of Cape wine dated from Tom Hood's "Comic Annual" for 1833. In those days, whatever might be the actual importation, he doubted whether much of it was sold under that name. Tom Hood described a widow lady, who kept an hotel at some place on the top of a hill, where the visitors would be supposed to have a good appetite after their walk, and who had "an ordinary, where she gave no ordinary dinner." After enumerating her fine vintages, the poet added :—

> Besides all these, she kept in store,
> Cape for the meaner sort—
> Who did not mind the stomach-ache,
> And could not pay for port.

All that had now been changed, the first step being that they no longer spoke of Cape, but of South African wine. Some 20 years ago, a great effort was

made to introduce South African wine to the English market, on account of the quantity of phosphorus it was said to contain, and an enterprising wine merchant, in those days, used to head his advertisements, "Phosphorus is life;" but, through the researches of some meddlesome chemist, it transpired that this phosphorus was not quite of the right sort, but was, in some way, connected with what had been delicately alluded to as the uncleanly habits of the people concerned. There were now, however, some admirable wines from the Cape; he had tasted one called "Drakenstein," of very fine quality—a clean, good, sound, wholesome wine, and a country which yielded that must be capable of yielding much more of the same sort. He hoped, in the course of the discussion, they would have some information as to the cost of carriage and freight, for, after all, the question was one of cost. Australia must give them a wine capable of competing not only in quality but in price with that of other countries, before a good market for her produce could be obtained.

Mr. B. P. Burgoyne desired to thank Mr. Bannister for his paper. He had brought to the subject not only his experience as an expert but that gained in the management of the Civil Service Stores, where he had discovered what suited the taste of the British public, and it was evident, from what he had said, that they were taking kindly to Australian wines. With regard to freight, they paid, by the Orient line, 22s. 6d. per hogshead; and by a German line, trans-shipped at Bremen, 17s. 6d.; but he could not recommend wines being sent by the latter route, as so much leakage occurred by the damage to casks in the trans-shipment.

Mr. Johann M. Prillevitz (South African Wine Company) said he should like to say a few words on behalf of the wines from South Africa. These wines were made solely from grape juice, without any addition whatever, grapes of the finest quality being bought there for 1s. 6d. a bushel. The question would naturally arise how it was that, even after the change in the duty, these wines were not more popular in England, and there were several reasons for this. In the first place the growers were perhaps hardly so energetic as those of Australia, nor had they amongst them at present such skilled persons from Germany and Switzerland as seemed to be the case in Australia. In former days they had, but not lately. Again, they had not much capital, and like most other people, being anxious to get rich quickly and with little trouble, were more disposed to invest what little money they had in gold mining shares than in the wine industry. Some two months ago an attempt was made to float a wine export company at the Cape, but it fell through for want of capital, though plenty of money would be found for the opening up of a gold mine, which might be altogether imaginary. Then, again, the merchants or exporters at the Cape laboured under the same fault; they wanted to get rich in a hurry. He had been eleven years in the Cape wine trade before coming to Europe, and during all that time he never found a wine merchant who would refuse to sell his wine because it was not properly matured if he could get a small immediate profit on it, quite regardless of the reputation the wine might get in the country it was going to. On the other hand, the most thriving trade in wine was done with what were called the eastern provinces, on the borders of the colony, where people's tastes were not so cultivated as in Europe, and the merchant thought what sold readily there would be equally appreciated in England. Then, again, in the matter of consignments a mistake was frequently made. Exporters consigned to their general correspondents, who had no particular knowledge of the wine trade. These agents would draw samples and send to the brokers directly wine arrived in the docks, when it was often sea-sick, and failing to effect sales in that way, they put the wine up to auction, and these public sales under such circumstances did not tend to re-establish the reputation of Cape wine. As a rule, the Cape merchants did not let the wine properly mature; they had some method of converting one-year old wine into three-years' old in about a fortnight, which did not suit the English palate. The English public had now an inclination to drink pure grape juice, and he did not see why the Cape and other colonies which could supply the article should not do so; but as neither the grower, the exporter, nor the consignee seemed at present quite alive to the situation, the only way was for an English company to be formed, who would send out qualified men to buy what would meet the English taste, and see that it was properly prepared, matured, and put in the market.

Mr. Fells endorsed the remarks which had been made as to much of the wine sent here from the Colonies not being properly matured. He had charge of all the wine in the Colonial Exhibition from Victoria and New South Wales, and his experience convinced him that that wine would ultimately be in great demand here. It was a good wholesome wine, but was often sent here too young. Last February he had 340 casks sent to the Exhibition, and large numbers of people came to see it, but as soon as it was settled it was sea-sick, and started fermenting, and he had much trouble with it. He got it in order, however, by degrees, and in the month of May it was fit to show, and was thoroughly appreciated. Out of the 340 casks, though some of the wine was only made in 1885, only 40 were unfit, and those he now had under his charge, and they would be all right by-and-by. He had no doubt that the Australian wines were the pure juice of the grapes, and if the British public would only take to them, they would do them more good than the compounds which came from other countries.

Mr. Hoffmeyr, as a Dutchman from Cape Colony, said all colonists owed a debt of gratitude to Mr. Bannister for his very able paper. He believed a great deal more might be done in England with Colonial wines, Australian as well as Cape, but when he looked at the tabular statements he was not quite so hopeful as some might be. He would not say much about the Cape, which was admitted to be a great sinner, but when he looked at the importation of Australian wine in 1865, 27,223 gallons, between three and four times as great as in the preceding year, he thought any lecturer in 1866 might have indulged in very sanguine expectations for the future. But when he turned to 1875, he found the importation was only 25,243 gallons, or less than ten years before, notwithstanding the phylloxera in France. Going further on in the Table he found the quantity imported had been very fluctuating, sometimes more and sometimes less, until he came to 1886, which gave the most promising figure of all, viz., 148,000 gallons, but that was the Exhibition year, when a great impetus was given to all colonial trade. The conclusion he drew was that a considerable effort was needed in England itself to promote the consumption of colonial wines. He believed the English wine trade was established in certain channels which it was very difficult to get out of, and it could only be changed by a considerable application of capital in England itself, as well as in the Colonies. Mr. Prellivitz had not spoken in very high terms of the Cape wine merchants and growers, but there was a good deal of human nature in those people, and if a farmer found gold-mining shares which had been issued at £1 were selling at £10 he was very apt, if he had a few pounds to spare, to invest them in a similar undertaking in the hope of making a similar profit, especially if he found he could make nothing at all by cultivating his grapes. If the Cape farmer found that by applying industry, capital, and intelligence to viticulture, he could produce an article which would find a good market in England at remunerative prices, the chances were he would produce that wine. Baron von Babo was very intelligently setting about the improvement of the Cape wines, and his lessons were being extensively followed. He knew many who made wine according to his methods, but he believed the bulk of them, unless they were aided by the mercantile community, both at the Cape and in England, would find much of their labour was wasted, and that they could get no higher price for their new product than they did for the old. With regard to the change in the trade after the alteration in the duty on French wines, he believed it was, in a great measure, owing to the fact that, in the meantime, the wine-drinking community had gone through a course of education. Up to 1862 they did not care much for claret, but preferred port and sherry, but then the fashion changed, and the 1s. duty only was imposed. But the Cape population did not go through the same education, and even to the present day the bulk of the people preferred a somewhat stronger and sweetish wine, which would not be appreciated in England. He believed, however, that the character of the wine would change as Von Babo's method was gradually adopted. The great lesson to be learned was, that the wine growers and the merchants must go hand in hand, and if capital from England were applied to the development of trade, both in Australia and the Cape, it would lead to a considerable increase in the export for both colonies.

Mr. Upington said as he had been for a number of years connected with the political history of Cape Colony, it would not be out of place for him to say a few words. He entirely agreed with his friend, Mr. Hoffmeyr, that it was very unfair to the wine grower of the Cape to cast upon his shoulders the whole blame of any shortcomings in this matter. He should rather say the chief blame lay on the mercantile community. The duty of any producer was to produce the article, and the duty of the mercantile community was to place that article in the market, and unless this was done, there was no use in the farmer improving his production. The question really was whether people, both in England and at the Cape, had sufficient interest in the matter to invest their money in endeavouring to obtain colonial manufactures. One was led irresistibly to the conclusion that the day was at hand when England would look to her colonies, not only for every necessary, but for every luxury of life. The sooner England realised that fact, and that it was her duty to assist her own people instead of assisting foreign producers, the better it would be, both for her and her colonies. When this was done, on behalf of the people whom Mr. Hoffmeyr said he represented, he could only say it would be found that the mother country had made no mistake whatever. The history of wine growing in South Africa was a most interesting subject. It began under the old Dutch Government, the first vines being introduced shortly after the settlement of the Cape peninsula, as what was called a refreshment station for the Dutch East Indian ships. When Commander Van Riebeek first went to that country viticulture was a very small industry, and he (Mr. Upington) sometimes reflected on the pluck those few people had in those days, in taking out vines in boxes at a time when the voyage was very different to what it was now, when half the crew were often down with the scurvy, and when the death-rate was enormous. It was in such circumstances the vine was introduced. Van der Stell, the founder of Constantia, did a great deal to develop the trade. The Cape wine at that time had a bad name, and samples were sent by the Dutch Government to Batavia, in the hope of finding a market for it. They also threw open the market in the East Indies, and offered every facility to the Dutch burghers to send it, by charging a very low freight. The difficulties, however, were very

similar to those now existing. The Dutch burghers at the Cape said this was of no use to them, because they were too poor to wait for a year until the returns came in, even if they had credit for the freight, and thus it fell through. Governor Van der Stell also issued a placard to the effect that no wine grower should touch his vintage until a certificate had been given by a Government Commission, and no wine should be disposed of until it had been tested and certified. Up to a very recent period that system was continued; and it struck him it would be very desirable to return to it, and to allow no wine to be exported to Europe unless it had the brand of a Government officer. People in England would then know what they were buying; but at present, when the wine merchant bought from every producer who brought his wine to him, and shipped it on his own responsibility, there was nothing to show the public that the wine was of a pure and wholesome character. Great strides were being made, and Baron von Babo, the Government wine expert, had again and again told him that he had no fear for the future of the wine industry in South Africa, as the farmers were now beginning to make their wine on correct principles, as laid down by him. In his report, laid before the House of Assembly, at the Cape, last year, he said—"If Cape wine is made on correct principles, it will be a most exquisite article." He only began his operations last year, and if a few years were given, to allow his system to work, he felt quite sure that the wine sent to England would meet with the thorough approval of the public." He did not agree with Mr. Prellivitz about the British palate being more educated than that of the Cape. He had tasted as good wine in South Africa as he could wish to drink, but you could not get it everywhere; it must be old wine. He would say, finally, that this was a subject of the most pressing importance. Everything in connection with the colonies, and the dealings of the colonies with the mother country, should be looked upon in England with the greatest favour; for a day was coming when England, with other countries around her, would have to look to her colonies for her markets and her supplies. They were ready to meet her, and all they asked was that a little assistance and consideration should be given them.

Mr. Bannister, in reply, said he would direct especial attention to the Australian figures which had been referred to by a previous speaker. As he had said in his paper, there was a great effort made in Australia at one time to enlarge the vineyards, a great many people embarked in wine producing, and after a while the supply was much in excess of the demand. It followed that much of the wine made was very inferior, and ,as a matter of course, the public taste went against it. About 1879 was just such a period when the exports greatly diminished, falling from 49,000 gallons in 1876 to 17,000 gallons. The variations in the quantity exported would be found to correspond very closely to what was done in the colony, either to forcing the market or to a time of depression, when people would not take the wine simply because it was bad. He had a letter that day from a gentleman, who said that in a certain year he received a consignment of wine from the Cape, and when it arrived he found in one cask about 25 per cent. of lees, thick wine which could not be put on the market. It followed, as a matter of course, that in all future consignments he would look very carefully to to see what the quantity of lees was. In the French market, at present, the wine merchants were so particular that they took note of the number of bottles drawn from every cask brought into the cellars, and if one shipper had more lees in his cask than another, when the merchant went into the market again, he not only took into account the price at which the wine was offered, but the quantity of lees, and if the price was about the same, and one man had racked his wine more than another, he was the shipper who got the order. It was the same with wine as with everything else; there were three things to look to—supply, demand, and quality. Neither in this country, in France, nor anywhere else, would they find philanthropy in wine-growing or drinking, and colonists must look at the matter from a simple business aspect. At present there was a great demand for French wines, which held their own in a remarkable manner, and there was not the least doubt either that the talent devoted to the production of wines for the English market in the South of France was most extraordinary. If colonists wanted a good demand, they must take into account the requirements of the market, and must have sufficient zeal, energy, and ability to supply what was wanted. Nearly all the wines in the Health Exhibition, and also in the Colonial Exhibition, went through his hands, and he must say that some of those wines were of remarkable quality. But if from any district wine was obtained of remarkable quality, it only required skill and application to get the same wine in neighbouring districts. He found some of the hocks, Burgundies, and clarets, very nice, delicate, and full of aroma, and he came to the conclusion that if we did not get all we wanted from Australia, it was not the fault of the country, but of the people engaged in viticulture. If they would find out what was wanted, he had the greatest expectation that in the near future a great portion of the wine consumed in this country would not come from the continent of Europe, but from our own colonies, and be drunk, not as hock from Germany, or claret from France, as it often was now, but as hock or claret from Australia. With regard to the Cape, it was right to say that the wines known as Pontac and Constantia always stood well on the market, although the others had gone down, and, looking carefully at the returns, he found that the consumption of Constantia had gone steadily up from the time of its first introduction. If the same care and attention were bestowed on the other wines, no doubt the same result would follow. He

hoped that in the course of the next twenty years the present annual consumption of about 148,000 gallons of Colonial wine would be multiplied into 1,480,000 gallons, and there was no reason why this increase should not take place.

The CHAIRMAN then proposed a vote of thanks to Mr. Bannister, which was seconded by Sir CHARLES MILLS, and carried unanimously.

Miscellaneous.

VARNISH RESINS.

By P. LUND SIMMONDS.

The number of substances suitable for coarse varnishes has lately become very numerous in Europe. Common resin is now purified by a patent process consisting of distillation with superheated steam, by which it is obtained nearly transparent and colourless as glass. Resins suited, however, for the preparation of the finer descriptions of varnish are still very limited. All plants produce, indeed, resins in a greater or less degree, but the trees which produce them in sufficient quantities to be of commercial value are to be found principally in South America, India, Africa, and New Zealand. These belong principally to the pine tribe, the *Dipteraceæ* (only found in India and the Eastern Archipelago) and the *Leguminosæ*.

Of the latter, the *Hymenaea* seem to be the trees from which the resins most nearly akin to the true hard, or fossil copals, are mostly derived. The copal of Africa and the dammar of New Zealand (known in commerce as kowrie gum), are the best known and most esteemed.

The word Varnish covers a very wide field, as the term, in its fullest sense, can embrace all the thousand and one preparations compounded for as many different purposes. An essential quality of varnish is that it must harden without losing its transparency, as it must not change the colours it is intended to preserve. It must exclude the action of air, because wood and metals are varnished to protect them from rust and decay. It must also be waterproof, else the effect of the varnish would not be permanent. And a point of primary importance is that it must possess durability. New uses are constantly being found for varnish, by which it embellishes the article to which it is applied, affording satisfaction to the buyer and profit to the manufacturer. A few notes on the chief varnish resins may therefore be acceptable.

East Indian dammar is the name applied by varnish makers to the resin of *Dammara orientalis*, imported chiefly from Singapore, which is straw-coloured, or, like pale amber, very clear or transparent. It is easily and entirely soluble in benzole, ether, or chloroform, less rapidly so in turpentine, forming a clear, nearly colourless varnish, which dries rapidly on exposure to the air. Dammar comes principally from the Lampong islands and Sumatra, and the yearly receipts may be given at about 32,000 cwt.

This resin is produced by many kinds of trees in the State of Perak. The principal are *Dammar mata kutching*, *D. Meranti*, *D. Lant*, *D. Degon*, and *Dammar Balk*. It is the sap which exudes spontaneously, and being exposed to the air, acquires a flinty hardness, from which the epithet batu, or stone, is given, to distinguish it from the softer resins. The dammar is found either in large masses, at the foot of trees which yield it, or floating in rivers, drifted to them by the floods of the rainy season. The natives apply it to most of the uses to which we put tar, pitch, and resin. Most of the family of *Dipterocarpeæ* yield balsamic, resinous juices, those of the genus *Dipterocarpus* the wood oils, and of *Vateria* indurated dammar. The natural order abounds in Sumatra, Java, and Borneo, which are the chief sources of the dammar of commerce.

In Borneo, dammar is generally found in the ground below the trees, but may occasionally be seen in huge masses, not unlike icicles, hanging from the sides of the trees. A single piece weighing 6 cwt. has been found on one tree, but necessarily these large masses get broken in collection. The value of the dammar found in the Sandakan district, North Borneo, is rarely over 10s. per cwt. Further to the north much better sorts are found, the dammar mata kutching (or cat's-eye), of Palaman, brings £2 per cwt.

Of resins, chiefly dammars, we import 20,000 cwt. from Singapore, and 6,000 cwt. from Java.

Two or three species of dammars are met with in British India, but are of no great commercial value. *Canarium strictum* is known in Malabar under the name of the black dammar tree, in contradiction to the *Vateria indica*, known as the white dammar tree.

The Sal tree (*Shorea robusta*) furnishes also a dammar, which dissolves much more freely and speedily in benzole than in spirits of turpentine. This resin is usually of a pale, creamy colour, nearly opaque. *Shorea sericea* yields a kind of dammar which closely resembles the Indian kind.

Hopea odorata, of Burmah and Pegu, yields the rock dammar of commerce, a yellow resin which dissolves readily. The trunk of *Hopea Mingarawan* furnishes a white dammar of a superior quality. The resin yielded by *Hopea Micrantha* in Borneo, Sumatra, and Malacca is not so good, but that obtained from Belambang is much sought after for the lustre it gives. This resin is of a yellowish colour, and exudes in large lumps from the trunk and branches. It is soluble in turpentine or benzole, and forms a clear limpid varnish.

The Kauri gum of commerce is the produce of *Dammara Australis*, a coniferous tree, which occurs

only in the north island of New Zealand, over a large area of land which has been exhausted by forests in past ages, and is now barren. The turpentine that has exuded from the dead trees is found at a depth of from 2 ft. to 3 ft. The export of this fossil resin has been steadily increasing the last thirty years. In 1855 only 355 tons were shipped, whilst in 1883, 1884, and 1885 the annual shipments were over 6,000 tons, valued at £320,000. We received in 1885, 81,000 cwt., valued at £254,000. This fossil resin is often found in immense masses, larger than those of any other known resin. Fine blocks were shown in the New Zealand Court at South Kensington last year, as well as large collections of trade samples of the different commercial varieties.

Copal of Zanzibar.—This, sometimes called Indian Animé, has been found to be the produce of *Hymenæa Mosambicensis*, or *Trachylobium mosambicense.* The South American species, *Hymenæa courbaril* also yield a good deal of resin.

The true, or ripe copal, is the product of vast extinct forests overthrown in former ages. The export from Zanzibar averages about 1,000,000 pounds annually. The raw, or true copal, is called Chackaze, corrupted by the Zanzibar merchant to jackass copal. Copal, it may be remarked, is the Mexican generic name for all resins.

Manila copal derives its name from the port from which it is shipped. There are two varieties, known as hard and soft Manila; the hard resembles kowrie in appearance, but is inferior in quality; the soft is a pale yellow kind resembling dammar.

From *Hymenæa courbaril*, the soft resin known in commerce as American copal, is obtained. The tree is very extensively diffused over the West Indies, British Guiana, Venezuela, Mexico, and in almost all the provinces of Brazil, though some other species of *Hymenæa* probably furnish the resin. It is found in many localities in a semi-fossil state, and is obtained by digging in the vicinity of the roots of the tree. The masses seem to have the appearance of a stalagmitic formation, arising from exudations from the branches of the tree dropping in the soil below.

Guibourtea copallifera is the principal, if not the sole, source of the copal resin of Sierra Leone. All the resin exported under the name of West African copal, may be looked upon as a fossil resin, produced in times past by trees which, at present, are extinct, or exist only in a dwarfed posterity.

The origin of the kind of copal known as Angola, is at present undetermined. Considerable quantities of copal are washed down during the rainy season from the slopes of the mountains. The natives subject the copal to a rude washing in lixiviated ashes, whereby the outer crust and its impurities are partly removed. It has, on arrival, to be further cleansed for the trade with extreme care, and without the use of acids, which are very detrimental to varnishes in causing them to run "pin-holey."

The flat Angola copal is sometimes called red animi, as it somewhat resembles it in appearance and quality. It is principally sent from here to Europe and America. The rounded water nodules, known as "pebble copal," assume this form, from the abrasion consequent on their being washed down by the rapid mountain currents, from the beds of which they are obtained.

The animé of commerce is a resin of great value to the varnish maker, but it is now largely replaced by copal. The best is obtained from Zanzibar, and is derived originally from *Trachylobium mosambicense* The finer qualities come from the northern districts of Wande. The imports are never very large, seldom amounting to 3,000 cwt. Of copal, the imports occasionally reach 20,000 cwt., but the imports from West Africa are only about 7,000 cwt. Of dammar the imports range from 3,000 to 7,000 cwt., and of kowrie gum, 70,000 cwt. to 80,000 cwt. annually.

EDUCATION IN URUGUAY.

Unusual attention appears to have been given in Uruguay within the last four or five years to the education of the masses. The United States Chargé d'Affaires at Montevideo says that education is now absolved from any denominational inhibition; in fact, the public schools, now over fifty for primary classes, and over one hundred for second grade, besides three public high schools, are open alike to all religious denominations. Of what are termed rustic or rural schools there are over one hundred and seventy, and the total number of scholars, in 1884, amounted to 27,000. Of private schools there were 430, having an attendance of about 20,000 pupils. Rudimentary instruction of some sort is compulsory upon all children between the ages of six and fourteen. An educational institution of a peculiar sort has been established and greatly fostered by the Government within the last few years. It is called *La Escurla de Artes y Oficios*, and its principal aim is to afford to the poor boys of the Republic an opportunity to learn different trades and professions at the expense of the Government. It is conducted upon a military plan, and its expenses are borne by the Ministry of War and Marine. The education is altogether practical, and the rules and regulations well-defined and understood, and these are strictly adhered to. An applicant for admission to this school must be of Uruguayan extraction, and over fourteen years of age at the time of entry. Vaccination is insisted upon. The applicant must be an orphan or his parents in indigent circumstances. His father, mother, or guardian must contract for him in writing that he is to remain for six years absolutely under the control of the principal of the school, with no interference from home or elsewhere. If taken ill he must be sent to the hospital, and return to the school as soon as able. Military discipline of the strictest kind is

observed. Mr. Bacon says that to show to wha, extent and proficiency the institution has reached, it is only necessary to state that the *Rivera*, a gunboat said to be powerfully built, was constructed entirely by the young workmen in this school, and launched by them. The Minister of War and Marine, in his last report, alluding to the institution, says that its progress and usefulness are felt more and more, from day to day, and that, in addition to the *Rivera* constructed there, a small steamer, the *Pas y Trabagot* has been built, and the steamers, *General Palleja* and *General Garibaldi*, are in course of construction at the school.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

APRIL 20.—"Electric Locomotion." By A. RECKENZAUN. W. H. PREECE, F.R.S., will preside.

APRIL 27.—"Appliances for Saving Life from Fire." By ARTHUR W. C. SHEAN.

MAY 4.—"Agricultural Education." By J. C. MORTON. The Right Hon. SIR THOMAS DYKE ACLAND, Bart., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock :—

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock :—

APRIL 19.—"South Africa." By MAJOR-GENERAL SIR CHARLES WARREN, G.C.M.G.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN. COLONEL DONNELLY, R.E., C.B., Vice-President of the Society, will preside.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 18...Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on Mr. Wheeler's paper, "Dilapidations and the Legal Obligation to Repair," and on Mr. P. E. Pilditch's paper, "Notes on Dilapidation Practice."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m., Rev. J. M. Taylor, "The Cycle and the Road."

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m., Canon Saumarez Smith, "Practical Optimism."

TUESDAY, APRIL 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Major-General Sir Charles Warren, "South Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Hopkinson, "Electricity." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Papers by Messrs. Grover, Fox, Stooke, and Matthews, on "Water-Supply from Wells," in the London Basin, at Bushey (Herts), in Leicestershire, and at Southampton.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. N. A. Humphreys, "Class Mortality Statistics."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Parkes Museum of Hygiene, 74, Margaret-street, of W., 8 p.m. Captain Douglas Galton, "Ventilation, Measurement of Cubic Space, &c."

Zoological, 11, Hanover-square, W., 8½ p m.

WEDNESDAY, APRIL 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. Reckenzaun, "Electric Locomotion."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Charles Harding, "The Storm and Low Barometer of December 8th and 9th, 1886." 2. Mr. G. Chatterton, "Report of the Wind Force Committee." 3. Mr. W. H. Dines, "A New Form of Velocity Anemometer." 4. Mr. G. M. Whipple, "Description of Two Maximum Pressure Registering Anemometers."

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Spring Exhibition.

Royal Society of Literature, 21, Delahay-street, S.W., 4½ p.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, APRIL 21...Royal, Burlington-house, W., 4½ p.m.

Linnean, Burlington-house, W., 8 p.m. Mr. P. Geddes, "Nature and Causes of Variation in Plants and Animals."

Chemical, Burlington-house, W., 8 p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "Art in Scandinavia."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Mr. Alfred Fryer, "Dust and Ashes—How to deal with them."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture I.)

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, APRIL 22...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir Frederick Abel, "The Work of the Imperial Institute."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Dr. Louis Parkes, "Water Supply, Drinking Water, and Pollution of Rivers."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, APRIL 23...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. Pickering, "Delicate Colorimetrical Thermometers and the Expansion of Thermometer Bulbs under Pressure." 2. Mr. R. H. M. Bosanquet, "Note on Magnetisation." 3. Prof. W. Ramsay and Mr. Sydney Young, "A Thermodynamical Relation."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Von Lendenfeld, "The New Zealand Alps."

Journal of the Society of Arts.

No. 1,796. Vol. XXXV.

FRIDAY, APRIL 22, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list, complete to date, of subscriptions by members of the Society of Arts to the funds for the Imperial Institute —

	£	s.	d.
Charles Denton Abel	20	0	0
Sir Frederick Abel, C.B., D.C.L., F.R.S., Vice-President	50	0	0
Sir Augustus J. Adderley, K.C.M.G.	25	0	0
William Anderson, Member of Council	50	0	0
Sir William Andrew, C.I.E.	20	0	0
The Attorney-General, M.P., Member of Council	30	0	0
H. F. Austin	1	1	0
Henry McLauchlan Backler, F.R.G.S.	10	10	0
W. J. S. Barber-Starkey	5	0	0
Henry Barcroft	2	2	0
Henry Gurteen Barker	5	5	0
William Henry Barlow, F.R.S., Member of Council	26	5	0
Robert P. Barrow	10	10	0
Edward Beanes	5	0	0
Mrs Beare (per P. F. Walker)	0	10	0
Sir Francis Dillon Bell, K.C.M.G., C.B., Member of Council	30	0	0
J. P. Benskin	10	0	0
Louis Biden	1	1	0
James Blackwood	1	1	0
George Blagden	2	0	0
Mark Henry Blanchard	10	0	0
John Bloomer	5	5	0
Francis Botting	0	10	6
Frederic H. Bowman, D.Sc., F.R.S.E.	2	2	0
Sir Frederick Bramwell, D.C.L., F.R.S., Vice-President	100	0	0
W. P. Branson, F.R.G.S.	5	0	0
William Brigg	1	1	0
Alfred W. Brind, M.Inst.C.E.	1	1	0
William Walter Brocklehurst	5	0	0
Edward M. Browell	5	5	0
Eric Stuart Bruce, M.A.	1	1	0
Wilberforce Bryant	52	10	0
S. M. Burrows (Messrs. Burroughs, Welcome, and Co.)	5	0	0
Colonel D. N. Cameron, R.A., C.M.G.	1	1	0
Alfred Carpmael, Vice-President	20	0	0
John J. Cater	1	1	0
Arthur Cates	10	10	0
Edwin Chadwick, C.B., Vice-President	10	0	0
Frederick Chamberlin	1	1	0
Charles Cheston, M.A., Member of Council	20	0	0
Carried forward	£562	13	6

	£	s.	d.
Brought forward	562	13	6
John Christie	5	0	0
Somers Clarke	5	0	0
B. Francis Cobb, Treasurer	10	0	0
Admiral Hon. Arthur A. Cochrane, C.B.*	10	0	0
Henry L. Cohen	5	0	0
Lieut.-Gen. A. C. Cooke, C.B.	2	0	0
Sir Daniel Cooper, Bart., K.C.M.G.	100	0	0
T. R. Crampton, Vice-President	30	0	0
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Charles E. De Rance, F.G.S., F.R.G.S., A.I.C.E.	2	0	0
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F. W. Docker	5	5	0
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Henry Doulton, Member of Council	100	0	0
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James Figgins	5	5	0
Major Lamorock Flower	1	0	0
Robert Galbraith, jun.	2	0	0
Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman of Council	50	0	0
W. E. Garstin	2	2	0
Robert Gill	1	0	0
Carlo Giuliano	10	0	0
Lieutenant Charles E. Gladstone, R.N.	1	0	0
George Godwin, F.R.S.	30	0	0
Colonel William Gray	10	10	0
Andrew Greig, C.E.	1	1	0
Acton F. Griffith	1	1	0
Edward W. Hammand	2	2	0
Colonel R. Harrison, C.B., C.M.G.	2	2	0
William Henry Haynes	0	10	6
Collected by ,, ,,	0	14	0
G. O. M. Herron	10	10	0
Frederic Hill	3	0	0
James Holdsworth	1	1	0
E. R. Holland	3	3	0
J. Satchell Hopkins	10	0	0
Henry Horne	5	0	0
J. Bennett Howell	5	0	0
Professor D. E. Hughes, F.R.S.	5	0	0
Robert Hughes	5	0	0
Charles W. Jackson	1	1	0
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Henry Joachim	2	2	0
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Sir Daniel A. Lange	1	1	0
Edwin Lawrence, LL.B., B.A.	100	0	0
Alfred E. Lean	0	10	6
Alfred Le Grand	1	1	0
Major-Gen. J. F. Lester	1	1	0
George B. C. Leverson	10	10	0
James Leverson	2	2	0
T. Hayter Lewis	5	5	0
Carried forward	£1,267	15	0

* Admiral Cochrane was present at Her Majesty's Coronation in Westminster Abbey, in 1837.

	£	s.	d.
Brought forward	1,267	15	0
W. Lindley ...	20	0	0
A. R. Macdonald ...	2	2	0
Mrs. McGarel ...	5	0	0
Silas E. Martyn ...	5	0	0
Major E. W. Mathew, J.P., D.L. ...	1	0	0
George Matthey, F.R.S., Vice-President ...	30	0	0
Messrs. Meyer and Mortimer ...	105	0	0
Edward Mucklow, J.P. ...	2	0	0
Stephen J. Newman ...	1	1	0
E. Chambers Nicholson ...	100	0	0
Colonel Chas. H. Page, J.P. ...	1	1	0
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Major-General C. Pasley, C.B. ...	3	0	0
James Paxman (Messrs. Davey, Paxman, and Co.)	100	0	0
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James Pitkin ...	2	2	0
W. H. Preece, F.R.S., Vice-President...	10	0	0
John Procter ...	21	0	0
Gilbert Purvis ...	1	1	0
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Sir Arthur Rugge-Price, Bart....	20	0	0
"W. R. S." ...	5	0	0
Sir Saul Samuel, K.C.M.G., C.B., Member of Council...	30	0	0
Henry Sandford ...	1	1	0
Edward L. Scott ...	2	2	0
Walter Severn ...	3	3	0
John Shaw (Barnsbury) ...	2	2	0
Rev. A. Short ...	1	1	0
Colonel E. C. Sim ...	1	1	0
John Smeaton ...	1	1	0
Sir Francis Villeneuve Smith ...	10	0	0
Surgeon-Major Samuel Smith...	0	10	6
James Solly ...	2	2	0
Major-Gen. Richard Hugh Stotherd, C.B. ...	2	2	0
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Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., M.P. ...	1	0	0
John Thompson ...	10	0	0
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Rev. J. P. Tomlinson ...	5	0	0
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H. Barlow Webb ...	10	10	0
Gysbertus Welling ...	1	1	0
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W. C. Wheatley ...	1	1	0
R. R. Whitehead, M.A., J.P....	5	0	0
Peter Williams ...	5	5	0
W. H. B. Winchester, F.R.C.S. ...	1	1	0
Thomas W. Wing...	50	0	0
Alfred Wise ...	3	0	0
James T. Wood, M.A. ...	10	0	0
Henry Edward Wright ...	10	10	0
John Yeats, LL.D. ...	5	0	0
	£2,127	0	6

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

Proceedings of the Society.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 20, 1887; WILLIAM HENRY PREECE, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Brearley, Benjamin J., Union Plate-Glass Works, St. Helen's, Lancashire.
Common, John Freeland Fergus, The Cedars, Llandaff-road, Cardiff.
Ellis, Herbert Owen, Forest-rise, Walthamstow, Essex.
Foster, Clement Le Neve, D.Sc., Llandudno, North Wales.
Hardwicke, William Wright, Stour House, Dovercourt, Essex.
Lubbock, Nevile, 16, Leadenhall-street, E.C.
Mooney, John, 14, Lansdowne-road, Didsbury, Manchester.
North, William, 28, Regent's-park-road, N.W.
Salamon, A. Gordon, 1, Fenchurch-avenue, E.C.
Simmons, George, Chertsey, Surrey.
Stokes, Frank, 49, Upper Baker-street, N.W.

The following candidates were balloted for and duly elected members of the Society.

Barnett, William, Court-street, Faversham, Kent.
Breeds, Thomas, 11, Albany-rd., St. Leonards-on-Sea.
Cowan, Edward, 4, Cazenove-road, N.
Greaves, John Arthur Robert, 12, Shobnall-road, Burton-on-Trent.
Kemp, David Skinner, 27, Coverdale-road, Shepherd's-bush, W.
Soper, Arthur L., 7, Cholmeley-park-villas, Highgate, N.
Warren, Thomas T. P. Bruce, Tamworth-villa, Earlham-grove, Forest-gate, E.
Whaley, John, 9, Furnival's-inn, E.C.
Wroughton, William M., Creaton-lodge, Northampton, and 30, Chester-square, S.W.

The paper read was—

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

No less than seven papers bearing upon the subject of the transmission of power by means of electricity have been read and discussed in this room within the last six years, Mr. Alexander Siemens, in 1881, taking the lead with an interesting address on "Electric Railways and the Transmission of Power by Electricity." This gentleman again favoured

us in April, 1883, with an account of the great progress made during an interval of two years by Messrs. Siemens on the Continent, and he was followed at the same meeting by Dr. Edward Hopkinson, who presented an equally interesting communication on "The Portrush Electrical Railway." A few weeks later, Professor George Forbes enlightened us with his most instructive paper, entitled "Electricity as a Motive Power."

The late Professor Fleeming Jenkin described, in 1884, an ingenious system of electric haulage called "Telpherage." During the same session, I made an attempt to explain the principle of applying electricity to the propulsion of "Electric Launches;" and last year, on the 22nd of January, Captain Douglas Galton, in his excellent paper on the "Results of Experiments on Mechanical Motors for Tramways at the Antwerp Exhibition," presented us with most valuable data concerning mechanical traction.

Yet, with all this vast amount of useful information before me, I have had little difficulty in selecting a point of view from which we may regard the subject to-night. The ground has been so well prepared on the various occasions enumerated, that there is now no necessity on my part to explain the principles involved in generating electricity, and transmitting or converting the same for the purposes of electric locomotion. I therefore beg leave to offer the following observations as an appendix to the aforementioned papers, and to bring forward fragmentary descriptions of details of construction, and also, where possible, of working expenses and the amount of traffic on several electric tramways in this country and on the continent of Europe.

Experiments with electric motors and their application to purposes of locomotion date as far back as 1834, when Professor Jacobi first investigated the principles involved. The history of these early attempts, as well as the work of subsequent inventors who helped to develop the ideas of Jacobi, Paccinotti, and others, up to the present day, would prove far more interesting than the present essay; but I trust that the facts and figures of this paper will in some measure compensate for omissions concerning historical data.

It has become the custom to distinguish between different systems of electric tramways, by the methods adopted in conveying the energy generated in the stationary dynamo to the electro-motor which moves along with the car, and we may divide these systems as follows:—

1. The system in which the ordinary rails serve as conductors of the electric current, the axles of the car being insulated from the wheel tyres, and circuit with the motor established through a contact brush, or roller, sliding along the rails.

2. The system of overhead conductors. In this a number of strong posts are placed alongside the line, carrying slotted tubes or rods of metal, upon which sliding or rolling contact-carriages are placed, and these communicate electrically with the car-motor by means of a flexible cable.

3. The system of the "third-rail conductor," which is placed between the ordinary rails, or alongside the line, on insulators a short distance above ground.

4. The system of underground conductors enclosed in a channel, with a central slot for the free passage of the contact-carriage.

5. The system of well-insulated underground conductors, with no channel, temporary contact being made through short sections of surface contact-rails with the motor on the car during its passage over that particular section on which the car is moving at the time.

6. The system of applying secondary batteries within the car, carrying stored energy along with it, whereby the vehicle is rendered independent, so that it can run on any line of suitable gauge without alteration to the roadway.

7. The system of applying secondary batteries to a separate locomotive, which hauls an ordinary car or cars behind it.

Members of the Society of Arts, and readers of the technical journals, will recollect that on the 12th of May, 1881, an electric tramway between the Lichterfeld station of the Berlin-Anhalt Railway and the Central Military School, a distance of one and a-half miles, was opened to the public. Not many weeks ago, I visited that district near Berlin in order to obtain some information concerning the working of the tramway, and I have the satisfaction of telling you that the electric cars, although in continuous operation for a period of six years, have exhibited no signs of deterioration, and there have been no mishaps worth mentioning. The rails, which serve as conductors, are laid along the high road principally, and a small portion of the line runs across fields. No special means of insulation were used, the rails being fixed in the

ordinary way to wooden sleepers, laid transversely along one side of the road. Electrical contact between sections of rails is effected through flexible copper loops. With such short lines of comparatively little resistance, the electromotive force can be kept low, and, in the case of the Lichterfeld line, it amounts to only 90 or 100 volts, and is therefore not dangerous to the touch of man or beast. Several roads cross this line, and at such crossing places the rails are cut out of circuit by means of underground cables; contact boxes, with switches, are placed near the crossings, in order that the current may be sent through these insulated sections of rails if requisite. The house containing the steam-engines and generating dynamos is situated close to the rails, but at a distance of about one-third of a mile from the Lichterfeld terminus. There are two steam-engines, each of 6 horse-power nominal, and two Siemens dynamos; one is a horizontal engine, and this is generally in use when one car only is running; the other is a Dolgourouki high-speed rotary-engine, coupled direct to the dynamo, running at 700 revolutions per minute; this latter comes into requisition when the traffic demands the second car. According to the printed timetable, one car makes 24 journeys a day, between 7.47 a.m., and 11.21 p.m.

I have not been able to ascertain the working costs of this line, but it must be very low, since the engines and dynamos are in the house, which also contains the pumping machinery of the district waterworks; one engineer and one stoker attend to both the hydraulic and the electric apparatus, the same boiler serving both purposes, and these men find time to attend to minor repairs. On the car is a driver, but no conductor. Each vehicle carries 24 passengers; it weighs, when empty, but including motors and gearing, 3·2 tons. The average speed is 12 miles an hour, and one journey occupies nearly eight minutes, for which a passenger has to pay 20 pfennige; this is nearly 2½d. About 100,000 passengers are carried annually. One remarkable fact in connection with this successful enterprise is, that the cars, although identical in every other respect, are fitted with different kinds of gearing, with a view of ascertaining practically the efficiency of each. Those who have devoted their attention to the subject of electric locomotion are well aware that the choice of the mechanical transmission between the fast running motors and the comparatively slow motion of car wheels is one of considerable difficulty. To the uninitiated it seems the easiest thing in the world to reduce, for instance, 800 revolutions of one shaft to 80 revolutions of another shaft; but when the arrangement has to be applied to a tram-car, where space is limited, noise objectionable, dirt and dust in abundance, then one obstacle after another seems to appear. This branch of our subject really deserves a separate and exhaustive treatment, if we had sufficient time at our disposal; but as I have chosen such a sweeping title, I shall have to confine my remarks on mechanical gearing within very narrow limits. With regard to the Lichterfeld cars, the one which ran some 13,000 miles per annum, or nearly 76,000 miles since the opening of the line, is fitted with a peculiar kind of transmission, little known in this country. The motor, in this case, is fixed underneath the floor, in the middle of the car, with the shaft of the armature parallel to the axles. The motor shaft carries a pulley of small diameter with 27 V-grooves cut upon its rim; one of the car axles has a large pulley with 13 grooves, and the other car axle carries a similar pulley upon which 14 V-grooves are cut. The wheel-base is 5 feet 9 inches, consequently the centres of the pulleys are only 2 feet 10½ inches apart. Within the grooves run 27 cords of spiral steel wires, so that one driving axle is worked by 13 and the other by 14 cords from one common pulley on the motor. The steel cords, a sample of which is on the table, are made of a pair of wires wound closely upon a mandril rather less than one-eighth of an inch in diameter; the mandril is afterwards withdrawn, so that a stiff and yet flexible spiral is left with an external diameter of barely $\frac{7}{32}$ of an inch. The ends of each spiral cord have steel eyes screwed into them and soldered, and when placed in position these eyes are connected by a steel wire link. One curious fact about these spirals is, that they stretch very little, and experiments have shown that one single cord will suffice to draw the empty car on a clean level line, whilst 8 cords were used for a car full of passengers; therefore, with 27 there is a good margin of safety. As may be expected, this mechanical arrangement works without noise or vibration. Some experience is required in putting the cords upon the pulleys, for, I am told, if stretched too tightly, they are liable to break at the joints, and if too loose they will slip when starting; but with careful attention on the part of the engineer in charge, very few breakages occur. There are only moderate

gradients on this line, the worst, of 1 in 100, is about 460 yards in length; the question, therefore, remains whether this kind of gearing would suit a more difficult line. The second spare car belonging to this tramway is fitted with pitch-chain gearing; as in the former case, the motor is placed centrally underneath the floor, with its shaft parallel to the car axle, but only one of the pair of axles is connected by means of the chain to the toothed wheel of the armature. There is some noise and vibration with this arrangement, more current is required, and slightly less speed is obtained with this vehicle than with the other; consequently, chain-gearing must be less efficient than steel cords, the motors and all other conditions being similar.

Another line on which the ordinary rails serve as conductors of the electric current is that of Mr. Magnus Volk, at Brighton. When opened by the Mayor of Brighton, on August 2nd, 1883, the line was only a quarter of a mile long, running from the Aquarium entrance to the Chain Pier; 30,000 passengers having used it during the first five months of its existence, Mr. Volk obtained permission to extend it as far as Kemp town, a distance of nearly a mile from the Aquarium. The rails are fastened to wooden sleepers which rest upon the shingle along the beach, and no special insulation is employed; the necessity of passing under the Chain Pier involved a gradient of 1 in 28 on the west side and 1 in 14 on the east side of the pier. Two cars connected together, and containing 60 passengers, mount these inclines without difficulty. Each car, when empty, weighs $1\frac{1}{4}$ tons, and with 30 passengers about $3\frac{1}{4}$ tons; the speed is limited to eight miles an hour. The motive power in this case is a 12 horse-power gas-engine placed at one end of the line, driving a Siemens compound-dynamo, which generates a current of about 20 ampères at 160 volts when one car is running. As a rule, only one car is used, but on bank holidays and special occasions, when the traffic is great, the second car is put upon the line. The average distance made by each car last year, I am told, was 23,475 miles, and the expenses per car mile amounted to only 2d. This is remarkably low, considering that gas is used in the prime mover, costing 3s. 3d. per 1,000 cubic feet, and this item alone amounted to 1·11d. per mile; for wages ·7 of a penny was expended; oil, waste, &c., ·07 of a penny, and the repairs to machinery came to ·12 of a penny per car mile. The number of passengers last year averaged 8·51 per car mile, and the total expenses amounted to 55 per cent. of the gross receipts. On the Brighton cars leather link belts are employed for transmitting the power of the motor to the driving axle; the armature shaft is provided with a 5-inch pulley; this gears into a 24-inch pulley, on a countershaft fixed under the car. Mr. Volk used plain leather straps at first, but found them unsatisfactory, whilst the linkbelts proved quite practical, after an experience reaching over a period of nearly three years. A sample of a worn-out belt of this description has been sent to me by Mr. Volk. The belts slip a little at starting, but this is not considered a disadvantage, since it eases the motor; the bearings of the countershaft are adjustable by means of a slide, so that any slack caused by stretching of belts may be readily taken up. No protection is provided for the gearing, there being no mud to contend with, but I fear that this arrangement would hardly be suitable for the ordinary street cars. Judging by the large traffic which the Brighton line enjoys, one would think that it is highly popular; it is so with the public, but a section of the Town Council is opposed to the enterprise. The line was severely damaged by storms, in September, 1883, December, 1884, and October, 1886, involving a large outlay for repairs, to the anything but "permanent way." That it is a success in every way, excepting the storms from within the Town Council, and storms from across the sea, may also be gathered from the fact that a million passengers have already been carried, without injury or mishap to one of them.

Coming now to lines worked by means of overhead conductors, on the plan of Messrs. Siemens and Halske, the most carefully constructed, if not the most important, is that of Mœdling, near Vienna. This is the property of the Austrian Southern Railway; the rails wind through a lovely country district for a distance of 2·8 miles, and terminate in that beautiful spot with the ugly name—Hinterbruehl.

I am indebted to Mr. C. Jenny, Engineer of the Southern Railway, and to Dr. Dolinar, electrician of the Moedling tramway, for their extreme courtesy in conducting me over the line and stations, and for allowing me to inspect every detail concerning the working of the same. Like most of the existing electric tramways, this has a large traffic during the summer months, but a comparatively small one in winter. The number of passengers carried during the year 1886 was

342,257, of these 320,000 came between the 1st of April and the 31st of October, whilst in the five remaining months only 22,257 persons availed themselves of this mode of transit. The month of August, with 72,600 travellers, stands highest in the list, and January, with 2,557 passengers, stands lowest of all. The revenue of seven months of the milder seasons is fifteen times as great as the revenue of the remaining five months, but the working expenses were not at all proportional, barely as five to one, and with all that the average cost did not amount to 3½d. per car mile, inclusive of every item of expenditure, the sum of which came to £1,700 for the year ending December 31st, 1886. The number of car miles was 91,002, with a consumption of 545 tons of coal, at 7s. 6d. the ton. This was a very inferior "brown coal," with an evaporative power of barely one-half that obtained with anthracite. The cost of fuel, therefore, came to ·54 of a penny per mile, representing a consumption of 13·4 lbs. per car mile. With coal of the best quality, 7 lbs. per mile would suffice, but the price of this, in Vienna, is more than double that of "brown coal."

The generating station is situated at the Moedling terminus; it contains three portable engines of 12 h.p. (nominal) each, and six Siemens compound dynamos, each capable of producing 500 volts and 30 ampères. When two loaded cars are running, *i.e.*, one electric car, to which an ordinary car is attached, the indicated power of one engine varies between 12 and 20 h.p., according to the position of the vehicles relatively to the line during the outward journey. From the plan on the wall, it will be observed that the track is not an easy one; it consists almost entirely of curves, with radii of from 60 feet and upwards. Moreover, the terminus of Hinterbruehl lies 120 feet higher than that of Moedling; thus the line consists of a series of gradients, so that for the outward journey a considerable amount of tractive power is necessary, whilst on the return journey the cars run almost entirely by the force of gravity, and the driver touches the switch only when starting and at the sharpest curves. During the winter months one electric car suffices, and then one engine and one dynamo are used, attended by an engine driver and a stoker. In summer, when three engines, six dynamos, and six double cars are running, three stokers are required. The maximum number of journeys, each of 2·8 miles, last summer was 180 a day, with six electric and six ordinary cars coupled in pairs, and the minimum number of journeys in winter with one car was 24 per day; the time allowed for one journey is 20 minutes. There are four stopping-places along the line, and the average speed allowed is 9⅓ miles an hour. The conductors—the metal ones, not the animate being on the car—are carried on posts 18 feet high and 90 feet apart, except on sharp curves, where they stand at a distance of 45 feet from each other. These conductors are made of slotted tubes, in lengths of 15 feet each, and soldered together when placed in position. To prevent them from sagging, stout wires are stretched over brackets on the tops of the posts, and fastened to the tubes half way between the posts. The bore has to be made perfectly smooth and clean, so that neither mechanical nor electrical resistance is offered to the contact carriage sliding within. The diagram shows the arrangements on an enlarged scale; the actual diameters of the tube are 1 inch internally and 1⅝ inches externally. The contact carriage consists of a flexible piece of flat steel, upon which three gun-metal pistons are fastened. These pistons, which have to be renewed every two months, are made in two halves, with springs in the middle, whereby a slight pressure is produced between the surfaces in contact. The resistance of the conductors is 2 ohms, and the insulation in damp weather never falls below 6,000 ohms. Measurements gave a difference of potential of 500 volts at the dynamo, and 390 volts at the furthest end of the line when three electric cars were running, and this would correspond to a current of about 18 ampères per car. All the electric cars on this tramway are fitted with spur gearing; but I will reserve any remarks on this mode of transmission until I am describing another line worked on the same principle. The Moedling-Hinterbruehl Tramway has been working successfully since 1884, at an average cost of 3·42d. per car mile, inclusive of every item of expense.

The second line, almost identical with the last one, as far as electrical details are concerned, is that of Frankfort-on-Main, in Germany. It leads from the "Roemerbruecke," in Frankfort, through the villages of Sachsenhausen, Oberrad, and through the town of Offenbach; its total length is 4·1 miles; it has a double track laid with ordinary tram rails, thus differing in this respect from the Moedling line, which has a single track with three passing places, and ordinary railway rails of a light construction. Single cars,

as well as trains composed of one electric and one ordinary car, run between Frankfort and Offenbach every twenty minutes, from six in the morning until eleven o'clock at night. The entire rolling stock consists of fourteen vehicles, ten of which are fitted with electric motors. All are constructed to carry twenty-four passengers; but the weight of the electric cars is four tons, empty, and that of the others about two and a-half tons. The engine-house is situated at Oberrad, nearly half way between the termini. It contains two horizontal steam-engines of 120 horse-power each, and four vertical Siemens dynamos, each capable of generating a current of 70 ampères and 300 volts. Ordinarily on weekdays, four pairs of cars are running, when one engine, working at half-power, is used for driving two dynamos. With eight electric cars and four ordinary cars on the road, the engines indicated 164 horse-power. The average speed allowed on this line is seven and a-half miles an hour, and one journey occupies forty minutes, inclusive of stoppages at eight stations.

The Frankfort Offenbach Tramway has been in operation since April, 1884; last year, 990,238 passengers were conveyed, and 292,269 car miles were run, at a cost of 3·83 pence per mile, including the following items:—

Wages and salaries of directors, clerks, &c.	2·23d.
Fuel (7·54 lbs. of coal per mile)	·65d.
Oil, waste, &c.	·13d.
Repairs of machinery, cars, and permanent way	·82d.

If we could deduct the directors' fees, repairs to roadway, and such items, which do not really belong to the costs of motive power and maintenance of the same, then the expenses per car mile might come to less than 3·5d.

With reference to the overhead conductor, I need only mention that the slotted tube is used in the same manner as at Moedling, with the exception that its resistance in the present case is only 1·6 ohms, and the contact carriage is somewhat differently constructed, as will be seen in the diagram on the wall. Instead of three gun-metal pistons made in halves, there are two solid iron pistons without expansion springs. These parts have to be renewed every three or four weeks, at the cost of 1s. for each carriage.

A skeleton plan of this line is shown on the upper diagram on the wall; the lower represents the Moedling track. There are several gradients, the stiffest of which is 1 in 32 for a distance of 100 yards; another of 1 in 45, 150 yards long, with a curve of 110 feet radius upon it; and a third incline of 1 in 80, 300 yards in length. To those who study the subject of mechanical traction, the following data relating to the tramway under discussion may be interesting. The energy expended was measured on the car as well as on the generating dynamo, simultaneously, when the total weight, propelled at the normal speed, was 8·35 tons, comprising one electric-car hauling an ordinary car and passengers:—

	Electrical Measurements. H.P. on Car.	H.P. at Dynamo.
Running on a level road	3·87	6·47
Running up gradient 1 : 45 without curve	8·00	13·5
Running up gradient 1 : 45 with curve	9·70	16·7
Starting up gradient 1 : 150	10·2	26·4

I have already stated that spur gearing is used on the Moedling cars as well as on those of Frankfort; concerning the working of the latter I will now submit a few particulars. The train of wheels on one of these cars consists of a pinion on the motor shaft having 17 teeth which gears into a spur-wheel of 56 teeth keyed upon a countershaft. On this countershaft is the second pinion of 26 teeth, and this drives the spur-wheel of 52 teeth fixed to the car axle. We get thus a ratio of 1 to 6·6, nearly, between the motor and the car wheels; the whole set of wheels weighs 4 cwt.; the electric motor, also, is very heavy, so that the driving apparatus of one car comes to about 26½ cwt. It must, however, be noted that the motor runs at the comparatively low speed of 500 revolutions. A considerable amount of noise is produced by this gearing, so that the sensation felt inside the electric car is anything but agreeable. As regards the economy of spur gearing for tram-cars of this description, the experience gained is not at all favourable; the pinion of the motor, for instance, which is made of hard gun-metal, wears out in a month; the diagram on the wall shows the teeth of one of these pinions in full size when new and after four weeks' work. The second sketch on the same diagram is a copy of the teeth of one of the cast steel spur-wheels on the driving axle, their shape when new, and after ten months' wear. One of the cars is now being fitted with wheels having double helical teeth, and it is expected that these will work more smoothly, and be more durable. I am indebted to Mr. Prins, the manager, and to Messrs. Dill and Strauss,

of Frankfort, for their kindness in conducting me over the line and premises, and for affording me every facility in studying the whole arrangements. Overhead conductors of a different form to those just described were constructed by Messrs. Siemens and Halske for the electric railways in the mines of Zankerode, in Saxony, and the Hohenzollern colliery, in Upper Silesia. The Zankerode line has been in operation since the autumn of 1882, and the Hohenzollern was started in August, 1883; another is now being constructed for the salt mines of Stassfurt. In all these, the conductors are made of bars in the shape of an inverted T fixed along the roofs of the mines. Sliding contact pieces grip the edges of the lower flanges of these bars, and insulated wires lead from the slides to the electrical switch on a small electric locomotive which hauls a number of trucks. An interesting description of the Zankerode line is given in Mr. F. J. Rowan's paper, recently read before the Mining Institute of Scotland. Mr. Rowan states that the cost of haulage, including 15 per cent. for depreciation of plant, came to only ·77 of a penny per ton, when 660 waggons were drawn per day of sixteen hours.

Concerning the Hohenzollern line, Mr. Zacharias, of Berlin, has kindly placed his notes, which contain many details of its construction and working, at my disposal, but unfortunately our time is limited, and I can therefore give very few particulars at present. Two sets of rails are laid underground, for a length of 820 yards, and there are several curves of from 15 to 30 feet radius; about forty trains run daily, with one locomotive and fifteen waggons; each waggon carries nearly half a ton of material, and the cost of haulage is said to be about ½d. per ton.

The steam-engine and dynamo are placed near the top of the shaft, 250 yards above the working level; when running at 277 revolutions per minute, the generator gives 350 volts and 37 ampères. Each waggon weighs when empty 1,210 lbs., and when loaded, a little over a ton; the electric locomotive weighs 2·1 tons, and the whole train of fifteen waggons 17·8 tons, running at an average speed of seven miles an hour. For transmitting the motion of the motor to the driving wheels, two pairs bevel wheels, one pinion, and two spur wheels are employed.

Among the lines on which the "third rail" system of conductors is used, the electric tramway of Portrush and that of Bessbrook, both in Ireland, must be considered the most important. The Portrush line, which was described in this room four years ago, is the longest electric tramway in the world; its rails traverse the country a distance of six miles, between the terminus of the Belfast and Northern Counties Railway and Bushmills. Since the reading of Dr. E. Hopkinson's paper, important additions have been made by the installation of two 50 horse-power turbines, driven by a 26-feet water-fall on the river Bush, which is 1,600 yards away from the nearest point of the tramway. The electric resistance of the line is 1·9 ohms; the generating dynamo gives a maximum current of 100 ampères, with 250 volts E.M.F. Since water-power has been applied to produce the electric energy, the working expenses have not amounted to threepence per car mile. The cars are fitted with pitch chain gearing. Mr. Traill, the managing engineer, informed me that he is satisfied with the working of this gear. An extension of this line is in contemplation. The Bessbrook-Newry Tramway is three miles in length, single rail of 3 ft. gauge, with gradients averaging 1 in 85, the maximum being 1 in 50. In this case also, water-power is available, there being a constant supply of three million gallons a day, with a fall of 28 feet, and part of this is utilised in a turbine which developes 62 h.p., and actuates two dynamos of the Edison-Hopkinson type, each capable of transforming the mechanical energy of 30 h.p. into electrical energy equivalent to 25 h.p., with an E.M.F. of 250 volts. Two electric cars, each capable of carrying 38 passengers, and weighing, when fully loaded, eight tons, run on this line; besides these, there are six goods waggons, with a capacity of two tons of freight per waggon. A train consists of one passenger-car and several waggons, generally three of the latter. The maximum speed attainable is 15 miles an hour, but, to conform to established rules, only 8 to 10 miles an hour are actually made. The line was passed on behalf of the Board of Trade in September, 1885, and from that time to the commencement of the present year, 30,000 train miles were run, 150,000 passengers carried, and 15,000 tons of goods were hauled. The cost of propelling a train containing the full complement of passengers and six loaded waggons is said to be fourpence per mile, including wages, repairs, and rental of water-power. Chain-gearing is employed for the purpose of transmitting the power of the motor to the car-axles. These particulars were kindly given to me by Dr. E. Hopkinson.

Mr. Holroyd Smith has devised an underground conductor contained in a channel, which is provided with a slot for the free passage of the electrical contact slide. The most important application of this system on a large scale is that at Blackpool, where it is worked on a line nearly two lines in length. Descriptions of this tramway have appeared in most of the technical journals, and Mr. Smith having read several papers before scientific societies, I need not dwell upon the details of construction, but will confine myself to a few general remarks. The roadway runs along the coast; ten cars of various sizes comprise the rolling stock, the largest having a seating capacity for 56 passengers, and the smallest carry 30 persons. At the generating stations there are two steam-engines, each of 25 horse-power nominal, driving four shunt wound Elwell - Parker dynamos, which give a maximum current of 180 ampères, with 300 volts. The E.M F. ordinarily employed is 220 volts, which is reduced to 168 volts at one end, and 185 at the other end of the line, the generating station being situated near the middle of the tramway. From all accounts this line has proved quite successful. It was opened in September, 1884. I have not been able to obtain particulars as to the number of car miles run and passengers carried, consequently I cannot establish the relative cost, but Mr. Smith informed me that the expenses do not reach 4d. per car mile. Whilst on the Moedling and the Frankfort tramways the resistances of the conductors are 2 ohms and 1·6 ohms respectively, the calculated resistance of the underground copper tubes at Blackpool is only ·041 of an ohm. We do not know the actual resistance of these conductors, but I should think it must very much exceed that found by calculation, considering the great fall of potential at different points of the line. In one of the papers read by Mr. Holroyd Smith, we find some extraordinary statements with regard to insulation, and consequently leakage, in his system of underground conductors :—

"Measurements were taken of the insulation of the line during construction, and 150 yards' length was found to give 4,490 ohms. The average working loss, through leakage, may be taken at 25 ampères, which, at an electromotive force of 200 volts, is equal to 7·2 h.p."

Professors Ayrton and Perry have devised a system of conductors which is said to overcome the objections against losses arising from bad insulation. Instead of supplying electricity to one very long, perhaps imperfectly insulated, rail, they lay by the side of the railway a well insulated cable which conveys the main current. A third rail, which is rubbed by the moving train, is divided into a number of sections, each fairly well insulated from its neighbour and the ground; but at any moment, only that section which is in the immediate proximity of the train is connected with the main cable, the connections being made automatically by the moving train. The loss of power by leakage is very much lessened through this arrangement, since any possible electrical contact between rails and earth is confined to that particular section upon which the train moves at the time, and connection from the surface rail to the insulated cable is made automatically by the pressure of the vehicles upon springs underneath the conducting sectional rails. Such an arrangement could scarcely be applied to ordinary street tramways, for if the sectional rails were laid flush with the roadway, then any other vehicle would, by its weight upon the rails, cause connection with the main cable.

In order to prevent the possibility of any extraneous force, other than that provided by the electric car, from making contact between surface rail and underground conductor, Messrs. Pollak and Binswanger have devised an ingenious plan, illustrated in a diagram on the wall. Underneath each electric car is a powerful magnet, and underneath each rail section, within a thoroughly insulated trough, is an armature of iron, which, when attracted by the influence of the passing magnet, makes contact between the cable and the surface rail, and through the latter with the switch of the car motor. No external force but that of a strong magnet, therefore, can draw electrical energy from the insulated underground conductor, and since the surface rail sections are each very much shorter than a car or train, no other vehicle following or preceding in the same track will be influenced by the current. Neither the Ayrton and Perry system nor that of Pollak has been tried on any tramway, therefore no opinion as to efficiency can be formed at present, but these systems seem worthy of an extended trial.

The idea of employing secondary batteries, the stored energy of which sets the motor in motion, and with it the car, suggested itself to the earliest inventors; indeed, the principle of applying batteries to the pro-

pulsion of a vehicle containing them was actually demonstrated in the year 1839, by a Scotchman named Robert Davidson; he used primary batteries, which proved a very expensive mode of generating electric currents; the method of storing energy in accumulators was unknown at that time. To-day, we are able to convert the energy of a waterfall or of coals into electricity by means of dynamo machines having an efficiency of 90 per cent., and more. The current thus produced can be made to decompose the acidulated water in the secondary cells which contain electrodes, or plates, capable of absorbing the oxygen and hydrogen resulting from the decomposition of water; and finally, the gases thus stored re-combine whenever we desire it, and manifest themselves in the form of electric energy capable of doing mechanical work through an electric motor. As transformations of energy always involve some loss, so there is a loss in this electro-chemical conversion, amounting to from 25 to 30 per cent. In order to establish a comparison between a system having conductors and one having accumulators carried in the cars, we have, in the first place, to ascertain the efficiency of the conductors in the one case and that of the secondary battery in the other. The efficiency of a conductor depends upon its resistance and the current transmitted. Let us take for an example a tramway similar to the one at Moedling, with a conductor of 2 ohms resistance, 20 ampères of current for each car, and 500 volts E.M.F. at the terminals of the charging dynamo. Supposing that only one car was running on this line, then the waste of energy would be practically *nil* at the commencement of its journey from the generating station, but it would be $20^2 \times 2$ when it approaches the furthest end of the line; the average resistance, or that due to half the length of the conductor is 1 ohm; therefore the average loss is only $20^2 \times 1 = 400$ watts, against $500 \times 20 = 10{,}000$ watts generated by the dynamo; consequently the efficiency of the conductor comes to 96 per cent., since we lose only four per cent. With six cars on the line equally distributed, and using, together, 120 ampères, the loss will be 14,400 watts out of 60,000 produced at the station, and then the efficiency is only 73⅓ per cent., and so on, by increasing the number of cars, and with it the current, the efficiency gets less and less. With the accumulator system, on the other hand, we have a constant loss, no matter how long the line, provided that the quantity of energy stored is sufficient for the time, and it matters not how many cars run at any time on the same tramway. If the cars at Moedling were fitted with accumulators, then the weight to be propelled would have to be increased by, at least, 20 per cent , and this would entail a corresponding augmentation of power, in order to keep up the same speed, therefore a greater consumption of fuel would be the result. But we have seen that the item of fuel really plays a minor part in the total expenditure, in fact, it is only about 16 per cent. of the whole, hence we need not look upon the question of the loss of energy with too critical an eye. According to the report issued by the jury of the Antwerp Exhibition, a *resumé* of which has been presented to this Society by Captain Douglas Galton, the consumption of fuel with the accumulator car came to 6·16 lbs. per mile, which, at 16s. the ton, costs little more than ½d. This car, however, carried only 34 passengers, and the line was practically level. On the other hand, the steam-engine employed was an old portable engine, which did other work besides charging the accumulators of the tram-car. From practical tests made with cars of my own design, here and on the Continent, I have ascertained that the consumption of fuel need never exceed 8 lbs. per car mile on ordinary tram-lines in towns, provided that the weight of the accumulator carried on the car does not exceed 25 cwts.

Viewed from the standpoint of convenience, the propulsion of tram-cars through the medium of secondary batteries must be conceded to be second to none. The battery occupies no valuable space when stowed under the seats, while the motor, with its attachments, can be placed underneath the car. There is no interference with the permanent way, and for city traffic such a service ought to be found eminently practicable.

The last system on our list is that of the separate locomotive, carrying accumulators within, and hauling an ordinary car behind it, I have placed this at the bottom of the list because it is the latest, but, from all appearances, it will be the first electric system to be adopted on a tramway in London. The early adoption of electric locomotives is partly due to the progressive spirit, the energy, and perseverance of the North Metropolitan Tramway Company, but mainly, perhaps, to the vigorous enterprise of the Electric Locomotive and Power Company,

who work the patents of Mr. Elieson, their energetic manager. I have recently had the privilege of witnessing trial trips with six of these locomotive engines. It was a pretty sight to see these vehicles running along Romford-road, one after another, on a dark night, each brilliantly illuminated by its own electric light. Mr. Elieson has prepared a diagram now on the wall, from which the details of construction can be seen. The mechanical connection of the motor with the axles is very ingenious. Instead of the electro-motor being a fixture, it turns round upon a vertical pivot. The horizontal armature shaft carries on its end a bevel wheel, which gears into a large circular rack. At the lower end of the pivot there is mitre gear connected to the driving axle. Reversal of motion can be effected by a clutch which brings one or the other mitre wheel of the axle into gear with that fixed to the pivot. Each of these locomotives weighs nearly seven tons, and this is the only disadvantage one can think of when examining the system. These engines have been ready for some time, they would have been earning money long before now, but for red tape and Acts of Parliament. Before we can run electric cars in this country we must have an Act of Parliament. To obtain one takes a year or more. It causes an immense amount of trouble and expense to get an Act of Parliament, and the worst of it is that each company has to apply separately for it; it is this awkward circumstance which retards the progress of electric locomotion on tramways in this country. Whereas, on the Continent of Europe and in the United States of America, there are dozens of electric tramways at work to the satisfaction of everybody, here in England, the home of the dynamo machine, the country where the electric motor has found its highest development, we have so few opportunities to demonstrate their advantageous applications. With regard to America, there are electric tramways at work in New York, Philadelphia, Baltimore, Saratoga, California, New Orleans, Toronto, Detroit, Windsor, Chicago, Cleveland, Montgomery, Denver, and in other parts. The American capitalist encourages electrical enterprise because it is worthy of every encouragement when untrammelled by unnecessary legislation.

I have made out a strong case in favour of electric traction. Any electrician sitting at home in his arm chair can reckon out upon paper what electric locomotion ought to cost, but I have made it my business to travel from place to place and examine into the details of the actual working electric tramways. Practical men want figures based on facts, not estimates. Through the courtesy of the engineers of the oldest lines I have obtained data which render the question of cost beyond doubt, and we have seen that the entire working expenses of those lines do not exceed—or need not exceed—3½d. per car-mile. There is no reason why these expenses should exceed 3d. per mile, when the most efficient machines of the present day will be applied.

Electric locomotion includes numerous other applications of the motor besides tramways, but I must stop short at this stage of the subject, having already trespassed beyond the usual limit of time.

DISCUSSION.

The CHAIRMAN said they had never had in that room within his recollection any paper on this subject in which the facts were more clearly enunciated than they had been in this case. It had hitherto been very generally the practice for those who brought forward papers on electrical matters to trust very much to their imagination and to their hopes for that future when those restrictive Acts of Parliament to which reference had been made had been swept away; but Mr. Reckenzaun had not given vent to the promptings of his imagination. One fact had struck him very much on making a very rough estimate of the cost, namely, that while the early lines established by Siemens and Halske showed a cost of about 1d. per ton per mile, in all the later lines the estimate came out about half of that, which showed a very great advance in the practical application of electricity. The cost of horses on tramways came to from 7d. to 10d. per car mile, which was probably about 3d. per ton per mile, so that there was a considerable difference between the cost of electrical haulage and that of horse power.

Mr. M. HOLROYD SMITH said this paper could not be called an exhaustive one, because it would take several days to treat exhaustively so large a subject, but it was more comprehensive than he thought it could have been in the time, and he complimented the author on having given so much information in so short a time. He might also be praised for having said so little about his own particular work. Considering he was one of the first to use secondary batteries for the propulsion of tram-cars, and that his work has been taken advantage of by more than one, who were now making a profitable employment of his skill, it was certainly very commendable that he had not said more on that point. He agreed with him that secondary batteries would be very ad-

vantageous on certain lines, but he did not agree with him as to their efficiency compared with that of direct working. There were two strong lines of demarcation in this matter — direct driving and batteries. Either primary or secondary batteries might be employed, and when using the direct current, it might be done with the actual rail, by overhead or side bars, or underground conductors. On going into the calculation, he should be able to show that, taking a line five miles in length, and working one car an hour over it, it would be cheaper to run it by secondary batteries; but if the lines were working a quarter of an hour service—and tramways did not as a rule pay unless the service was more frequent than that—it would be much cheaper to use direct driving. Even with a central channel constructed in the same manner, and at the same cost, as he had laid in Blackpool, it would cost less to construct a five-mile line, and equip it with channel, motors, gear, engines, dynamos, &c., when driving direct, than to equip all the cars and provide the surplus batteries, &c., for the secondary battery method. He should also say that the cost of the construction of the central channel at Blackpool was not to be taken as the standard for the future. As had been said, the resistance of these conductors was very low, and it was purposely so arranged, because he saw it would be better to spend a few hundred pounds more than was absolutely necessary on the copper tubes which formed the conductors, and on the structural details of the central channel, than to run any risk of failure, and therefore, in every item he had erred on the side of safety. It would be quite possible to construct a line at a little more than half that cost, and making that important alteration to the calculation, it would be found that direct driving would compare still more favourably with secondary batteries. In towns like London, where there were busy thoroughfares, tramway directors found the rail their greatest trouble, and omnibus and cab drivers were always using bad language about the groove which would form along side the rail, they did not want another rail, until further advance was made in public opinion, and it was possible that tramway companies in such a situation would adopt secondary batteries; but as he had pointed out in that room before, he regarded secondary batteries merely as a means of educating the public mind. One point which would be very interesting to discuss at greater length than was then possible was that of gearing, and he would again compliment Mr. Reckenzaun in not having brought forward his claim as being the first to use worm gearing on large tram-cars, although he (Mr. Smith) had used it on a small experimental car before, but he did not venture to adopt it for large cars until he saw Mr. Reckenzaun was successful. He said most unhesitatingly that he found it the most effective mode of transmitting the power from the motor spindle to the axle, taking all points into consideration. He might mention that the reason he could not give more detailed information to Mr. Reckenzaun, was that his directors had special reasons at the time for not desiring the details of their results to be made public, but he might say that the practical working at Blackpool was more economical than any of the figures given in the paper. He must take exception to one calculation put forward tending to show that by increasing the number of cars on a line the efficiency would decrease very rapidly. That was entirely contrary to his experience. He found that during the winter months, when only three cars were running, and the number of passengers per week was under 3,000, the total working expenses were about £20; in the summer months, when the passengers were 45,000, and there were ten instead of three cars, crowded instead of empty, the total working expenses were only £45. He was also struck with the figures given as to the number of passengers carried, and the car accommodation on other lines. On none of the lines had they cars which would seat 56, as they had in Blackpool—and very often they carried from 60 to 70; and instead of reckoning the people by tens of thousands, or even hundreds of thousands, they were now in the second million, and not one single accident had happened to anyone. With regard to the diagram with Messrs. Pollak and Binswanger's name upon it, illustrating a magnetic system of making contact between an underground conductor and a sectional surface rail, it was evident to him that no working test had been made, because he knew from his own numerous experiments in the same direction that the details there shown would not be successful in practice.

The CHAIRMAN inquired if the Blackpool Company had paid a dividend.

Mr. M. HOLROYD SMITH said it had, and not only so, but having, at the request of the directors, taken some fees due to him in shares instead of cash, he had sold them at 10 per cent. premium, and was, therefore, better off in consequence.

Sir JOHN JENKINS said he was connected with a tramway or short railway, from Swansea to the Mumbles, one of the oldest in the kingdom, the Bill for which was originally for a canal, but though it passed as such on the second reading, it came out of the House of Commons as a railway, in 1804. The cost of running on this was less than on ordinary tramways, and the question in all these cases was really which was the cheapest motor. As Mr. Holroyd Smith had said, there was a great objection to electricity on account of the third rail, but independently of that, he did not think the time had yet arrived when electricity could compete with steam power, where it was practicable to use it. Still they were much indebted to the scientific gentlemen who occupied themselves with this subject, and who, he trusted, would ultimately achieve a success which

would be beneficial not only to themselves, but to the nation at large. The cost of Mr. Reckenzaun's mode of working would be about $3\frac{1}{2}$d. per train-mile, but the cost of the small line he referred to was not more than half that. It ran not upon the road, but parallel to it. Of course, on great railways, he knew the cost was much higher, and horse-power, as the Chairman had said, came to about 7d. or 8d., and, in some places, 9d. per train-mile. On the railway he referred to almost every possible motive power had been tried, including sails, but nothing was so economical as the steam-engine.

Mr. MAGNUS VOLK thought the spiral wires referred to in the paper, running at a very high velocity, would wear considerably, and would not be successful. A somewhat similar plan was tried at Shoreham, and it seemed as if the whole thing would be torn to pieces in a few days, but possibly that might be due to faulty construction. Pitch chains were used on the Ryde pier railway, which he lately visited, and he was informed that they suddenly gave way, without any warning, causing considerable delay. Spur gearing had been used in Ireland, but though when first fitted it was tolerably silent, when he was there, it made so much noise that conversation in the car was almost impossible. He had found leather-link belts the best of all. He first tried single leather, but this broke every day or two, then double belts, which did not last much longer, as one lap slipped off the other. The leather-link belts had now been in use three years, and the portion shown had helped to drive a car over 50,000 miles. It was not worn out, but was a piece taken out to shorten the belt, which would have to do the next season's work. They stretched a little on being first put on, but there was an arrangement for taking up the slack. Toothed gear he found caused a great deal too much vibration in the car to be pleasant, though some people liked it, thinking it was spare electricity given off which did them good. The Brighton line was not perfect by any means, but he had from time to time made various improvements, and he had a great deal of opposition to contend with. Still, next August, he should have kept the line open for four years; he had run about 100,000 car-miles, and carried about a million passengers, the cost being just under 2d. per car-mile. All repairs were paid for out of revenue, but he put aside nothing for depreciation, for he never knew during the winter whether he should find the line there at all in the morning. Apart from damage by storms, it had paid a dividend of 20 per cent. With regard to light railways running through a poor district, he would remark that if steam were employed you must carry a considerable number of passengers to make it pay at all; but with electricity you could run a small car, seating five or six people, at almost the proportionate expense that you could carry thirty or forty, and thus, where it would not pay to run half-hourly, you might run a car every five minutes, and so work up a traffic. He agreed with Mr. Holroyd Smith as to the comparatively small extra cost of working extra cars. Last summer, for the first time, he worked a second car, and when his quarter's gas bill came in he found it was only increased by £3. Great pains had been taken at Blackpool to secure a very low resistance in the conductors; but if more pains had been taken in the insulation, he thought a better result would be attained, for he found that Mr. Smith's loss by leakage was just about the same as his own, where there was no attempt at insulation at all except by the sleepers. He should like to know Mr. Smith's experience as to the electrolytic effect of the current that escaped. He had found some $\frac{3}{4}$ in. bolts, which he put in last October, were last week reduced to about $\frac{3}{8}$ in. He did not think the magnetic system would be practicable, for a car going at anything like a fair speed would not have time to act on the armatures so as to pick up the current. The idea was very pretty and clever, but he did not think it would work.

Mr. KAPP said he had had no experience of electric tram-cars, but he knew something about gearing, and he did not think the spur gearing had yet had a fair trial. Mr. Reckenzaun's worm gearing had been very successful, but that was probably because it was well adapted to the work it had to do, and other gearing equally well designed might also answer as well. The noise could be avoided in various ways; you might have slanting teeth, or might split up the width of the wheel into narrow portions, so as virtually to have several wheels side by side, and shift them by a small angular distance, less than the pitch of the wheel, and so obtain a tooth consisting of several steps. In this way the violence of the blow of two teeth coming into contact would be very much reduced, and it was this blow which caused the noise. He had seen a very large spur gear on this principle on one of the large steamers of the Messageries Maritimes, the propeller shaft being geared to the engine shaft in this way, and the noise was hardly more perceptible than that of a shaft directly driven.

Mr. R. CAPPER said the question after all, with regard to the application of electricity to tramway working, was whether it would pay. He was interested in the railway mentioned by Sir J. Jenkins, which was now 84 years old, and naturally, having to carry three-quarters of a million of people a year, they looked at all these things very closely, but he had never yet come across any instance of an electric motor, as applied to tramways, which it would answer their purpose to adopt. There was still a field open to anyone who could show them how to make that six miles of line pay better by electricity than it did at present with locomotives.

General BRINE thought electricity would never pay as a motive power, or take the place of steam, which could hardly be surpassed. If anything were

likely to interfere with it, it would be petroleum. Electricity might do very well on the Thames, or in tram-cars, going at the rate of seven to ten miles an hour, but anything beyond that was out of the question.

Mr. Binswanger said he thought the system nvented by Mr. Pollak and himself, had been rather severely criticised. Seeing that it had only been completed a few months, there had been no opportunity to try it practically, but gentlemen of quite as high standing, and as large experience, as Mr. Holroyd Smith, had spoken very favourably of it, and the models which had been constructed worked very well. In an ordinary street you could not use an open channel, which would become full of water and clogged with dirt, and if the conductors were enclosed, he did not think any other mode of making contact would be so good as a magnet.

Mr. Richardson said he was interested in the North Metropolitan Tramway Company, and he hoped they would be able in a short time to show some practical results at Stratford. Within the last year they had obtained the necessary Act of Parliament, and the application was now before the Board of Trade for permission to run the engines of Mr. Elieson. When the system had been practically tested, there would come the question of cost, but he did not think on this point Swansea could be taken as a criterion for the metropolis, for coal there was much cheaper than in London. Besides that, the line ran by the side of the road, on agricultural land, where there was no chance of accident, and any locomotive could be used, whereas in the metropolis one which was almost noiseless would have to be employed. Their small district, where they only carried 45,000,000 or 50,000,000 of passengers per annum, could not compete with Blackpool or Brighton, but they were under more stringent regulations, and would not be permitted to lay down a third rail; there were quite accidents enough with two. They were endeavouring to give the plan a thoroughly fair trial, and were laying down very substantial rails, weighing 90 lbs. a yard, so at to carry well the engines of seven tons each.

The Chairman, in proposing a vote of thanks to Mr. Reckenzaun, said they were much indebted to Mr. Richardson for his reply to the somewhat dogmatic assertion of General Brine, that electricity would never pay as a motive power. In one sense that was quite true, because electricity was not a motive power; it was a means by which motive power could be transmitted from one point to another, and as a means for the transmission of energy it had certain peculiar advantages, which sooner or later must make it one of the most useful agents for this purpose which nature afforded. He was quite sure that, after the remarks of Mr. Capper, more than one electrician would rush down to Swansea and submit a proposal by which the traffic over the pretty railway to the Mumbles would be carried for less than half what it now cost.

The vote of thanks having been carried unanimously,

Mr. Reckenzaun, after thanking Mr. Holroyd Smith for his complimentary remarks, said he had probably misunderstood him slightly. Of course the loss of current through resistance increased with the number of cars, but any engineer would so proportion the size of his conductor to the probable traffic, that that loss should not exceed a certain maximum. He had purposely said very little about secondary batteries, not because he was personally interested in them, but because he had desired to confine himself to accomplished facts. He had given the figures as to various lines in actual works, and was only sorry he had not been able to obtain as full details from Mr. Smith as from other engineers. It was not worth while disputing who was the first to use worm gearing; anyone was at liberty to do so, and he hoped many would try it. He should be very glad if Mr. Smith could furnish the exact cost per car-mile on his line. With regard to Sir John Jenkins, his remarks referred rather to a railway than a tramway, and there was a great difference between the two. The traction power necessary on a railway was only about one-third that on an ordinary street tramway with a grooved rail, which was always more or less clogged with dirt; and any comparison between steam and electric motors must be made with reference to the particular circumstances of each case; you could not make a general comparison. Some locomotives on town tramways had given results as low as $2\frac{1}{2}$d. per mile when the engines were new, but after a time, when repairs were included, they worked out as much as 9d., the cost of repairs being much greater than that of providing motive power. He did not think Mr. Volk could have seen the spiral wire he had described, which would have been abandoned long ago if it had not worked satisfactorily. With regard to Mr. Capper's observation, he would admit that electricity could not compete with steam on ordinary railways; it did not profess to do so; but he believed there was a great future before it on tramways, where the conditions were different; where they had to compete with horses, or with steam-engines under special restrictions as to noise and smoke, which caused a great waste of energy. Even in the case of railways, where water power was available as at Portrush, electricity might eventually be able to compete with steam.

FOREIGN & COLONIAL SECTION.

Tuesday, April 19, 1887; Lieut.-Colonel R. C. Hamilton, R.E., Member of Council, in the chair.

The paper read was "South Africa," by Major-General Sir CHARLES WARREN, G.C.M.G.

The report of the meeting will be printed in the next number of the *Journal*.

Correspondence.

THE PURITY OF BEER.

The issue raised in my letter, published in the Society's *Journal*, April 1st, is a very simple one. Referring to the figures given (p. 518), I must point out that Mr. Salamon has entirely omitted the quantities of sugar used by brewers from October 1st to December 31st, 1880. I repeat that (excepting 1886) the largest quantity of sugar used by brewers was in the year ending September 30th, 1880, the final twelve months during which the Malt Tax was levied. The amount used that year was 1,320,590 cwts. During the following twelve months it was 1,141,747 cwts. Mr. Salamon says it was 56,267 tons, an amount that falls short of the actual quantity used in the succeeding four quarters, omitting the last quarter of 1880. This happened to be a very heavy one, sufficiently so to make a difference to the total of the whole year of 16,405 cwts. I maintain that it is improper and misleading to say that there "has been an increase in the use of sugar since the repeal of the Malt Tax" during the years 1881-6, as the proper year for comparison is the last when malt paid duty. Mr. Salamon's contention that 1880 was an abnormal one, is not supported by fact. Even taking his own figures, he shows that in 1877, 40,406 tons were used. In 1878, it rose to 56,000 tons, an increase of 15,594 tons, or 38·5 per cent. In 1879, there was a small decrease of 3,800 tons, but in 1880 a further rise of only 13,829 tons, or 26·4 per cent. for the year, and for two years an increase (since 1878) of 10,029 tons, or only 17·9 per cent., an average of less than 9 per cent. per annum. If the figures of the previous ten years are examined, it will be found that there is nothing abnormal in the increase of the quantity of sugar used in 1880. Some previous years show relatively a much larger increase, and 1878 a larger actual increase.

There is no need to complicate the question by elaborate calculations and masses of figures. Anyone might guess that the entire suppression of one quarter would affect the sum total of ten years to a very small extent, as the total difference would be simply the fluctuation of increase or decrease of the particular quarter so excluded, compared with the other quarter that took its place. I certainly do not admit that my statement has been made with "undue haste," or without careful comparison of Mr. Salamon's ingenious tabulation with official returns. In questions of the kind, it is certainly desirable to use official figures in the equivalents most commonly employed; hence I have always used the reports of the Commissioners of her Majesty's Inland Revenue just as they appear.

H. STOPES.

THE APPLICATION OF GEMS TO THE ART OF THE GOLDSMITH.

Sir George Birdwood, M.D., LL.D., K.C.I.E., writes, with respect to his remarks in the discussion after Mr. Phillips's paper on "The Application of Gems to the Art of the Goldsmith" (see *ante* p. 450):—

"Since my remarks were published in the *Journal*, I have purchased a most interesting book, 'The Text Book of Astrology,' by Alfred Pearce (Cousins and Co.), in which, at pages 5 to 7, the author distinctly states that the stones of Aaron's breastplate are zodiacal, giving in detail some most interesting views on the subject, published by General Vallancey in the latter part of the last century, in the 'Collectanea Orientalia,' and other antiquarian periodicals,"

Obituary.

THOMAS LASLETT.—Mr. Laslett, late timber inspector to the Admiralty, who prepared the report on the timber exhibits in the Colonial and Indian Exhibition for the volume of Reports lately published, died suddenly at Woolwich on the 6th inst., in his 76th year. He was born in London in 1811, and at an early age entered Chatham Dockyard, where he served about eight years, and then made four voyages to New Zealand (between the years 1833 and 1843) to procure timber for H.M. Government. In 1847-8-9 he was purveyor of timber in the East Indies. Subsequently he had a foreign appointment to survey the forests in Asia Minor, Broussa, Herzegovina, Bosnia, Croatia, Styria, &c., for which service he received the thanks of the Lords of the Admiralty. In 1866, he was again complimented by their Lordships on the very satisfactory manner in which he conducted for them the purchase of timber in Dantzic. In 1869, he was appointed visiting timber inspector to the Admiralty, and in 1880 he retired. He was elected a member of the Society of Arts in 1865.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

APRIL 27.—"Appliances for Saving Life from Fire." By ARTHUR W. C. SHEAN.

MAY 4.—"Agricultural Education." By J. C.

MORTON. The Right Hon. SIR THOMAS DYKE ACLAND, Bart., will preside.

MAY 18.—"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S.

The papers for the remaining meetings of the Session will be selected from the following.

"Cottage Industries in Ireland." By MRS. ERNEST HART.

"Miners' Safety Lamps." By EDWARD H. LIVEING.

"Development of the Mercurial Air-pump." By PROF. SILVANUS P. THOMPSON, D.Sc.

"Textile Fibres in the Colonial and Indian Exhibition." By C. F. CROSS.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

APRIL 29.—"Village Communities in India." By J. F. HEWITT.

MAY 27.—"Indian Tea." By DR. T. BERRY WHITE. H. S. KING, M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 17.—"The West Indies at the Colonial and Indian Exhibition." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 26.—"Ornamental Glass." By J. HUNGERFORD POLLEN. COLONEL DONNELLY, R.E., C.B., Vice-President of the Society, will preside.

MAY 10.—"The Architecture of London Streets." By E. J. TARVER. E. C. ROBINS, F.S.A., will preside.

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE.

All the above dates are liable to alteration.

CANTOR LECTURES.

The Fifth and Concluding Course will be on "The Chemistry of Substances taking part in Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

May 2, 9, 16, 23.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 25...Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m.
Actuaries, The Quadrangle, King's College, W.C., 7 p.m.
Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

TUESDAY, APRIL 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. J. Hungerford Pollen, "Ornamental Glass."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. E. Ayrton, "Electricity."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., $8\frac{1}{2}$ p.m.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned discussion on papers by Messrs. Grover, Fox, Stooke, and Matthews, "Water Supply from Wells," in the London Basin, at Bushey (Herts), in Leicestershire, and at Southampton.
Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Prof. H. Robinson, "Drainage Construction."
Anthropological, 3, Hanover-square, W., $8\frac{1}{2}$ p.m. 1. Mr. R. A. Cunningham, "Exhibition of Aborigines from North Queensland." 2. Mr. C. H. Read, "The Ethnological Bearings of the Stone Spinning-top of New Guinea." 3. Lieut. F. Elton, "Extracts from Notes on Natives of the Solomon Islands."
Horticultural, South Kensington, S.W., 11 a.m. Fruit and Floral Committee.

WEDNESDAY, APRIL 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Arthur W. C. Shean, "Appliances for Saving Life from Fire."
Geological, Burlington-house, W., 8 p.m. 1. Mr. H. G. Lyons, "The London Clay and Bagshot Beds of Aldershot." 2. Mr. W. H. Hudleston, "Supplementary Note on the Walton Common Section." 3. Rev. A. W. Rowe, "The Rocks of the Essex Drift."
Patent Agents, 19, Southampton-buildings, W.C., $7\frac{1}{2}$ p.m. 1. Mr. A. J. Davies, "Threats of Legal Proceedings and the 32nd Section of the Patents Designs and Trade Marks Act of 1883." 2. Discussion on Mr. Allen P. Jones's paper, "Trade Marks."
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. H. Adams, "The Use and Care of Chains for Lifting and Hauling."

THURSDAY, APRIL 28...Royal, Burlington-house, W., $4\frac{1}{2}$ p.m.
Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture II.)
Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Professors W. E. Ayrton and John Perry, (1) "Measuring the Co-efficients of Self and Mutual Induction;" (2) "Driving a Dynamo with a very short belt."
Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Professor W. Corfield, "Sanitary Appliances."

FRIDAY, APRIL 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. J. F. Hewitt, "Village Communities in India."
United Service Institute, Whitehall-yard, 3 p.m. Major G. Mackinlay, "Accuracy of Artillery Fire."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. H. S. Hele Shaw, "The Rolling Contact of Bodies."
Civil Engineers, 25, Great George-street, S.W., $7\frac{1}{2}$ p.m. (Students' Meeting.) Mr. Alfred Chatterton, "Flour Mills and their Machinery."
Browning, University College, W.C., 8 p.m. Paper by Mr. A. Symons.

SATURDAY, APRIL 30...Board School Managers (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m. Annual Meeting.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. R. Von Lendenfeld, "The Australian Alps and the Origin of the Australian Fauna."

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FRIDAY, APRIL 29, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen under the following conditions:—

1. Prizes are offered to Art-workmen in certain classes of Art-workmanship enumerated below. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—

(i.) Copies of existing works.
(ii.) Modifications of existing works.
(iii.) Original works.

4. In awarding the prizes, the judges will take into account the following points:—

1. Originality or beauty of design.
2. Fitness of treatment.
3. Excellence of workmanship.

5. Before the award of prizes is finally made the candidates must be prepared, if called upon, to satisfy the Council of their competency.

6. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

7. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for any accident or damage of any kind.

8. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

9. All the prizes are open to male and female competitors on equal terms.

10. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

11. All articles for competition must be sent in to the Society's House on or before Saturday, 3rd December, 1887, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope giving the name and address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House, or, if the necessary arrangements can be made, at the South Kensington Museum.

12. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the discretion of the judges.

Prizes are offered in the following eight classes for the present year as follows:—

1. Painted glass, £25, £15, £10.*
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.

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* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.

5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.

6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.*

7. Hand-tooled Bookbinding, £25, £15, £10.

8. Repoussé and chased work in any metal, £25, £15, £10.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. BARRETT, Mus.Bac., Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing Monday, 23rd May, 1887.

Full particulars can be obtained on application to the Secretary.

MUSICAL PITCH.

The following letter, from the Adjutant-General to the Forces (Lord Wolseley), has been received by the Council :—

Horse Guards, War Office, S.W.,
13th April, 1887.

SIR,—With reference to a proposal, which has been made to this Department, to alter the musical pitch of this country, so as to correspond with what is commonly known as the "French Pitch," I have the honour, by desire of the Field Marshal Commanding-in-Chief, to acquaint you that His Royal Highness has no objection to the adoption of the new pitch for military bands, provided the expense involved thereby of altering the band instruments is not allowed to fall upon public funds.

Should it be possible to find the sum required to carry out the change, viz., about £10,000, from other sources, the new pitch could be adopted in the bands of the British Army without delay.

I have the honour to be, Sir,
Your obedient servant,
WOLSELEY, A.G.

To the President of the Society of Arts,
John-street, Adelphi, W.C.

* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, April 19, 1887; Lieut.-Colonel R. C. HAMILTON, R.E., Member of Council, in the chair.

The paper read was—

SOUTH AFRICA.

By MAJOR-GEN. SIR CHARLES WARREN, G.C.M.G.

In speaking this evening about South Africa, I propose to treat the subject generally, and not from a particular point of view, except that I shall endeavour to confine my observations, so far as is practicable, to those topics which relate to the development of the resources of the country. But I must premise that, in my opinion, this development must depend in as great a measure upon the policy pursued by the governing races, and upon the individual and collective characteristics of the inhabitants, as upon the capacity of the country itself for production.

We have instances all over the globe of countries, rich in mineral and agricultural wealth, which are now lying idle or retrograding on account of the feeble or supine character of the Government, which, as a rule, results from radical defects in the characters of the people; and on the other hand, we have many brilliant instances of countries with very limited resources, inhabited by thrifty, energetic races, who, in struggling to get a bare living, have acquired that necessary "go" which has brought them and their country to the front among nations.

It may be too much to say that the very richness and wealth of a country may tend to hinder its development and progress, and that if the people were compelled from poverty to exert themselves a little more, the yield would be greater, for this is not invariably found to be the case; but we do find, in a great number of cases, the exertions of a people are in an inverse ratio to the wealth of the country.

When we look around at the struggles of nations, we cannot help being struck with the remarkable effect of wars and internal troubles upon the people when a good cause has had to be upheld. Wars, and turmoils, and strife

have been not injurious in themselves, but have stimulated people to greater exertion, so that, in many cases, the additional labour and exertion called for under exceptional circumstances in a given time has exceeded the cost of wars, and the nation has been a gainer by the transactions.

War may thus be a distinct blessing to a nation, in causing the people to put out their energies, and is often a necessity to prevent stagnation and decay of a race. Gibbon tells us, with regard to the last days of the Roman Empire, "the long peace, and the uniform government of the Romans, introduced a slow and secret poison into the vitals of the empire: the minds of men were gradually reduced to the same level, the fire of genius was extinguished, and even the military spirit evaporated."

And with such examples before us, we cannot look upon South Africa, with its history of continuous and seemingly unnecessary wars and internal strife, and its peculiar geographical configuration, without feeling, "Here is a country which requires for its development a very special treatment. Perhaps these wars and strifes are in reality necessary to produce the energy and 'go' among an indolent people, by which alone they can be forced on towards the development of their resources." South Africa is wanting in some of the geographical characteristics which enable a new country to go ahead when first populated, but I rather incline to think these very characteristics are those which will enable it, in after years, to take a lead and go ahead when it becomes more thickly populated.

We must always recollect that a country when developed represents a very little original capital, and a great deal of trading with that capital. The produce of a country is represented very often by a small amount of fertility, and a great amount of man's labour. In this country our riches, to a great extent, are the labour of man, and though we do not see it so clearly here, we can see it very distinctly in a new country, where a farm of 6,000 acres may be bought for £300, and sold, in ten years, for £3,000; not because the land itself has increased in value, but because the labour of man has been sunk in improving the soil, and building, fencing, and making dams, and opening fountains.

I was much struck with a remark on this subject, made some time ago to me by the Mayor of Port Elizabeth, when pointing to a beautiful garden near that city, where there had formerly been dry veldt, or almost desert. "There," he said, "you have a specimen, not of what this country can produce, but of what this people can produce out of this country; that garden represents not so much the richness of the soil but the labour of the man."

With this fully in view, I will now give a description of the development we may reasonably expect from South Africa, provided the energy of the people is sufficiently stimulated, and their labour properly directed.

Extent of South Africa.

It is first necessary to define the meaning of the term South Africa, as all do not agree in its extent. I take it to mean all that portion of Africa from the Cape of Good Hope, extending northward as far as the Zambesi. There are several reasons why the Zambesi should be the limit.

(*a*.) As a river it is a natural boundary, extending east and west more than two-thirds the distance across South Africa.

(*b*.) It is the natural limit beyond which white people cannot in safety and health bring up their children.

(*c*). The wants and requirements of the British Empire do not at present appear to make it desirable to exercise any direct control northward of this line, say lat. 16° S.

I assume, in thus mentioning the want of our empire, that it is now well agreed among a great majority that, for the purpose of our trade, commerce, and very existence as an empire, the possession of South Africa is an essential item; and it is pretty obvious, judging from after events, that the recent expedition to Bechuanaland was as advantageous in marking Great Britain's determination to hold South Africa at all risks, as it was to give succour to distressed natives. In fact, as a very significant incident, as soon as our expedition had accomplished the first portion, that is to say, had vindicated our far-stretched power in so wild and inland a region, the primary cause of our expedition — the assistance of the natives — was to a great extent allowed to vanish and disappear.

The Zambesi marks the limit of South Africa as a colony in which children of European extraction can be reared, because the tableland of Bechuanaland and Matabeleland within the tropics fall down towards the Zambesi; it is only in the high lands within the tropics of South Africa that white children can be successfully brought up.

General Geographical Description.

South Africa extends from lat. 16° S. to lat. 34-49° S. It is triangular or wedge shaped, and may be said to extend 1,200 miles from north to south, and 2,000 miles from east to west at its northern extremity. It is as extensive as our Indian Empire.

It differs from North and South America, and Europe, and Australia, in that it possesses high table lands, extending over the greater portion of its surface. This gives it two peculiarities.

(*a*) The tropical and sub-tropical portions are, for the most part, so greatly elevated that the average temperature more nearly accords with that of other portions of the globe of several degrees higher latitude.

(*b*) The rivers are not navigable, but are, in fact, a series of cataracts towards the coast. This cuts off and isolates the interior, and renders the populating of the country, in the first instance, by Europeans, a very slow process.

We may thus look upon South Africa as a country of peculiar geographical characteristics, which tend to impede the process of immigration and absorption by white races in the first instance, but, as I will proceed to point out, it is possible, nay, probable, that these very characteristics may tend to give it peculiar facilities for supporting a larger population in the not far distant future.

It is not easy readily to give the geographical characteristics in a few words for so vast a territory, but it may be said that, in proceeding northward from the Cape, the country rises in two or more distinct plateaus, until the Orange River is reached at a height of upwards of 4,000 feet, so that, as the lower latitudes are reached, the land becomes more elevated, this tending to keep an equal temperature throughout. In journeying north of the Orange River, the country rises higher and higher, but not in distinct plateaus, to a height of 6,000 to 7,000 feet, and then falls considerably to the Zambesi.

Taking the country from east to west, it may be said that, after gentle rises from the seacoast to about 100 miles inland, it suddenly rises precipitously along the line of the Drackenberg to a height of 7,000 to 8,000 feet; from thence it has a gentle fall across the continent until nearing the western coast, where again it falls steeply. This does but give a very imperfect general outline of a configuration which, if I attempted to describe in detail, would occupy the whole evening.

The result of this peculiar configuration is well worth noting and laying stress upon. Nearly the whole of the south coast and interior of the country, as far as the Zambesi, is of a temperature suitable to northern Europeans, such as Dutch, German, and British; while the east and west coasts are extremely hot and malarious, more suitable to southern Europeans, Portugese, Spanish, and Italians.

At the present time the climate at Delagoa Bay, the mouth of the Zambesi, and on the western coast towards Angra Pequena is of a deadly nature to delicate Europeans and children, and, indeed, probably to women of Southern Europe, and I am under the impression that, in 1876, there was only one European woman living at Delagoa Bay.

As we look upon South Africa as a Colony, and not as a system of trading stations belonging to the mother country, it necessarily follows that the English, Dutch, and German merchants engaged in importing and exporting goods, if they wish to live with their families, are forced to take up their abode on the southern coast between Cape Town and Durban. As the energy which turns special attention to commerce is at present so much centered in the northern Europeans, we are compelled to consider that the convenience of those engaged will force the trade of the interior away from the natural ports, on the eastern and western coasts, towards the southern ports for many a long day, even should a proper fleet of steamers be put on the Zambesi. Though, of course, it is possible that any very heavy goods may be sent by more direct routes, and it is also possible and probable that restrictive tariffs, vexatious delays, and exorbitant railway dues may deter Cape Town and other ports from the advantages which seem otherwise certain to accrue. Looking to the country north of the Transvaal —the rich and fertile parts of Bechuanaland, Metabeleland, and Moshunaland—there cannot be a doubt that the Zambesi route is the natural artery of commerce; but there is another hindrance at present to its development, viz., that the mouth of the Zambesi is so situated that steamers homeward bound must either undertake the long voyage round by Zanzibar, and suffer the heavy dues and possible detention in the Suez Canal, or else the cost, delay, and risk of several days' extra steaming round the coast as far as the Cape of Good Hope. There is much to be said, therefore, in favour of the commerce of the interior of South Africa being likely in the

future to find its way out to the coast by a long railway or waggon journey to the southern ports, which are inhabited by northern European races.

If we now look at the map of South Africa, we shall see that the central portion is occupied by Griqualand West and the portions of Bechuanaland which were occupied by the expedition of 1884. To so full an extent is this practically the centre, that I have been at trading stations, not many miles apart, where stores were got up from the mouth of the Orange River, Cape Town, Port Elizabeth, East London, Durban, Delagoa Bay, and even Angra Pequena. The recent completion of the railway has, however, now given the advantage to Cape Town and Port Elizabeth.

This district is rich in diamonds, but it is richer on account of its vast stores of water, now, in so many cases, running below the level of the soil, but hereafter to be utilised, and not allowed to run to waste. It possesses a number of natural fountains of considerable capacity, but it also has the great Orange and Vaal rivers coursing through it, and effecting a junction.

It has been called Adamantia, the land of diamonds, but it also possesses gold, silver, lead, and other metals. It possesses a town, of which the late Premier of Cape Colony, Sir Thomas Upington, has recently said, "I believe Kimberley to be the key to interior South Africa ...... if the diamonds were exhausted to-morrow, I believe that Kimberley, as a trade centre, would maintain its prosperity." In this he is right, provided the Cape Colony will look after its true interest, and avoid present petty jealousies.

It was Great Britain that guaranteed the money to push the railway on to Kimberley from the Orange River, as a recognition of the services of the Bechuanaland Expedition, the Cape Colony having refused to forge the one last necessary link which should connect the avowed centre of commerce, this key to interior South Africa, with Cape Town and Port Elizabeth.

Now, I administered the government of the colony of which Kimberley was the capital, before it was annexed to the Cape Colony, and perhaps it may be thought that my strong affection for that portion of the world may make me over sanguine, but I find it a great pleasure that I can cordially agree with Sir Thomas Upington on this one point. Kimberley is the key to interior South Africa as a trade centre, apart from the value attached to it as being the spot from which the diamond supply of the world is now obtained.

I believe the country about Kimberley will in the future support an enormous population of agriculturists. Under proper management there is room for thousands and thousands of people on the fertile plains, which are now dry veldt, but which are in the future to be irrigated by the water now running waste to the sea.

But before entering upon this subject, it is necessary to give some indication of the agricultural prospects of the country.

In South Africa there are summer rains in parts and winter rains in parts. For the most part, along the southern coast, the moist ocean winds deposit their moisture during the cold season, and when this is the case wheat can be grown. These winds, passing over the mountain ranges forming the edges of the plateaus, are depleted of moisture, and on reaching the elevated plateaus are dry. If this were not so, these high plateaus would become frozen wastes in winter, and the grass would be withered up.

The elevated interior of South Africa depends for its rainfall upon the equatorial summer currents which come southerly, laden with moisture, which, however, is not always precipitated over the continent of South Africa. Thus, during dry summers in the interior, it often happens that there is moisture above and intense drought below. Water is deposited on the high lands by means of heavy showers almost invariably in the summer, and generally in the afternoon, though in a good season it will rain for one or more days continuously.

The result of these summer rains, which fall in torrents, is that wheat cannot be grown except by irrigation in early spring. This is an important feature, as there is every prospect of growing corn on the high lands, except that the rainfall comes at the wrong time, *i.e.*, when the corn should be ripe instead of when it should be sown. There are, therefore, two courses open, either to adopt a special series of crops suitable for summer rains, or else to grow corn by irrigation, and cut it before the summer rains commence; but irrigation is, at present, an expensive process.

Now, it has been noticed in South Africa that feastings and famines go in cycles of several years over large districts, and sometimes even locally. In some parts it is not unusual to meet with farms where there has been, practically, no rain for several years, and sometimes, not far off, there may be farms which may have been rained on plentifully year

after year, and yet observation will show that there is no local peculiarity causing the drought or moisture; on the contrary, after some years, the dry farm may be favoured, and the watered farm may become dry.

The secret lies in the fact that when, owing to some electric disturbance, rain falls upon a particular district, the land, by reason of its dampness, again attracts the moisture in the passing clouds, while, on the contrary, the dry soil repels it. Once having arrived at this conclusion, the future fertility of the interior of South Africa is secured. All that is required is such an arrangement, by irrigation or otherwise, as will moisten the ground on a large scale, when the rain clouds come overhead, and plentiful falls of rain year by year are secured. For it is not that during certain years there is no moisture in the clouds, but that the clouds fail to drop their fatness at the right time.

Various attempts, in recent years, have been made to prove that the country is drying up; old inhabitants remember the day when present dry hollows were once dank *vleis*, the resort of the sea-cow, and they recollect the dry rivers of the present day running full of water; but records also point to years of excessive drought. Yet there cannot be a doubt that the sheep farmers, and the workings of the diamond-fields, have gone far to endanger the prosperity of the country, and droughts have been more and more excessive.

In former years there were vast jungles of trees and shrubs where the elephant roamed, and the grasses there were different to those the sheep like. Even within five or six years the whole nature of the grasses will be changed by bringing sheep upon new farms. Over acres and acres the tall Tambookie grass, 8 feet in height, used to wave and screen the earth from the sun's rays, and preserve the moisture in the soil. So that after a fall of rain the water might lie for weeks covering districts where the sun could not touch it. But within the last thirty years there have been great changes made.

The Dutch farmer says he does not like trees, because he cannot see his sheep at a distance, so he cuts down whenever he can find a market. Around Kimberley, for a hundred miles, the old forests have been cut down to supply the hundreds of furnaces, and the ground exposed to the sun. The Tambookie grass has disappeared, and the sheep have made sluits by constant passing down to the rivers, and these have widened from year to year by the rains, so that after a fall the water flows quickly to the sea.

But this can all be remedied; the injuries done by man to the climate can yet be repaired; new forests can be grown of more useful wood than the mimosa. But more particularly can the country be fertilised by irrigation.

A few years ago, Kimberley was given over to dust storms, very little water was available, and trees and flowers could scarcely exist; now there is plenty of water in the city, and trees and flowers grow abundantly. The water is pumped up from the Vaal river about sixteen miles distant. I have always been in favour of a canal being brought into Kimberley from the Vaal river, near Christiana; if this were carried out, the surplus waters might be used for irrigating the lands on either side, and enormous productions would result. This could be done on the eastern side of the Vaal river, but there is a piece of territory on the west side of the Vaal river, consisting of several hundred thousand acres, which can be readily irrigated from the Vaal river, near Warrenton or Hebron. If works were here commenced on a large scale, there would be room for hundreds of agricultural labourers. The water is plentiful and good; it can be led by gravitation; the soil is excellent, and there is a good market.

It is impossible to view this country, all ready for irrigation works, with the enormous water-power ready at hand owing to the fall in ground, without seeing the great future that South Africa possesses. A fall of water 4,000 feet in height, when properly utilised, is indeed a mine of wealth to the country—far more valuable to South Africa than all the diamonds and gold put together.

But it is not merely about Kimberley that good irrigation works can be executed. Not a drop of water from the great river systems should be allowed to go to the sea without being utilised to the full extent, in a country where water is wealth.

The evil at present is, that the rivers and brooks are deep below the surface, the Orange River being in some instances over fifty feet below the level of the soil. The result is, that the water is, as a rule, too deep down to be used, and when it is high enough, it is a torrent too powerful to utilise.

What is wanted is a system commencing among the roots of the rivers' dams, and reservoirs, constructed in such a manner that the water after a heavy rain can be

turned out upon the plains, and allowed to stand and drain off gradually. When this is done, there will be a steady flow of the rivers throughout not only the rainy season but also in the winter, and the water can be brought out and run along the side of the main artery, which should only be used as a safety valve for an unusual fall of rain. The minor attempts which have been made in this direction all show that there will be a great success in the future, though failure has taken place in the past. Even irrigating by steam on the Orange River has only just proved a failure. What will be the result when the river furnishes the power, and not only irrigates, but also ploughs and reaps.

I look upon these miles of cataracts—these useless waters which now run wasted to the sea, after doing what destruction they are capable of—as the wealth of South Africa, the power that is to secure it a grand future.

But, first and foremost, there must be cheap means of transit, both for heavy and light goods. Canals, no doubt, will some day take the heavy goods over the plains when the fall is not too steep, but railways are a necessity, and they must precede the occupation of the land. They must not be too expensive; at present the tariff is quite prohibitive, and their use is almost reduced to zero.

One of the points that struck me most particularly in South Africa, in 1876, was the remarkable price of meat and flour—sixpence a pound each. It struck me that no country could ever get on when such prices could obtain, and though these high prices are reckoned by some as a sign of prosperity—and it was only a few days ago a friend was lamenting to me that, owing to the abundant crops this year everything is dirt cheap and he could not sell—it seems to me very odd reasoning that, in a year when the country can afford to export largely, instead of importing, the producer should complain of the low prices. It is evident that some persons in the country in a good year must make money, and if it is not the producers, it seems to me it is their own fault.

The fact is, the people in South Africa are too well off, and the country is too thinly populated for it to go ahead. This can readily be remedied, and will be remedied in a few years, but it should be remedied at once. The remedy is to prevent the natives being dispossessed of their farms by the white men. As long as this goes on, the progress of the country is retarded. What does the occupation of the district between Stellaland and Goshen by white men mean—nothing more or less than the extirpation of thousands of industrious, thrifty natives, and replacing them by five hundred white families. Those natives were growing corn, and fattening cattle, and buying British manufactures; but when they are dispossessed, the ground is turned into sheep walk, the rain is diminished, and the white families who come in live on fat mutton and milk, make their own shoes, and use their grandparents' clothing, and stockings they have none; and yet, if these 500 families had been obliged to remain on the farms of their parents, instead of being indolent farmers, they would have turned to, and irrigated, and dug, and fertilised the land with water, and made it productive.

What South Africa wants is pressure put upon the inhabitants to stay on their farms and work; when that is once accomplished, the future of South Africa as a great country is secured.

Unfortunately, we do not in this country fully realise what is best for the Boer, for the British, for the natives, for South Africa; it is all in one direction—protection of the natives in their lands, and limitation of the white farmers within theirs. We derive our present policy from the events of 1878, when the natives attempted to drive the white man into the sea (at that time the Dutch and the native races were well balanced—each was fearful of the other); but we were too energetic, routed the natives too fully, and have ever since then endeavoured to keep them under; whereas, for the influence of the country and benefit of our commerce, we should protect them.

I hear from Barkly, by the last post, that the Cape Colony proposes to push a railway north of Kimberley towards the gold fields. This is good; if something is not done quickly, the Cape Colony may find alongside of it a strong, healthy colony, abounding with riches, with Delagoa Bay for its port. If this once occurs, the Cape may not find it so easy to bring the goose to life again that lays the golden eggs.

There are various matters which may lead to a separation. The railway tariff to Cape Town is vexatious; the Cape politicians have peculiar views; and there is tendency on the part of the majority of the indolent Dutch population to coerce or govern the less numerous but more energetic British. This

has been given effect to by our Cape politicians of British extraction, in their eager competition for the Dutch vote, being more Dutch than the Dutch themselves.

If this matter is not carefully attended to, there may arise a breach betwixt the portion of South Africa to the north and south of the Orange river, and that northern portion, which is becoming more English in feeling day by day, may break away and form a State independent of the Cape Colony. This would affect commerce and trade, which would then be diverted to Delagoa Bay and Angra Pequena. The safeguard against this is a railway, and it should be commenced at once.

But the question occurs, in what direction shall it run? I hear from Barkly that ministers have decided to run it through the Transvaal, but that if Great Britain will guarantee the money they will run it through British Bechuanaland. Whether this is correct I know not. There are Cape ministers in this country who may give a satisfactory reply. It is quite clear however, that the want of a railway in a northerly direction from Kimberley may possibly very seriously affect the present currents of trade in South Africa.

My object has been to show that the development of South Africa very much depends upon the political situation, that the geographical peculiarities are in favour of a brilliant future; but that the country is at present too productive for the population, and that the present tendency to destroy native races is all against its development. What is wanted is a limit to extension by the present farmers, or, on the other hand, a great influx of Europeans. The present changes daily taking place owing to the opening up of the gold fields will probably overcome and neutralise the political retrogression during the past year, and we may shortly see a large British population in the Transvaal.

DISCUSSION.

Mr. GORDON CAMERON said he had listened with a great deal of pleasure to the paper. The point which had the greatest interest for him, as being largely interested in Transvaal gold mines, was the comparison drawn between Delagoa Bay and Cape Town. It was becoming pretty well known that the railway from Delagoa Bay into the interior was in course of construction, and the completion of the line to Pretoria was only a matter of very little time. That line would pass through the richest known mineral district in South Africa, and through the large coal fields of the Transvaal right up into Pretoria. The advantages of that line would be seen, when he stated that it would pass through a well-watered and fertile country as far as Pretoria, and an extension of the line would go up through Matabele Land, one of the grandest countries in South Africa, and would tap the interior trade, much in the same way as the line from Kimberley, with this advantage, that it would have a well-watered fertile road the whole way, whereas the line from Kimberley would have to pass through the Kalahari desert to a very great extent. It was said that, in 1876, there was only one white woman in Delagoa Bay, and she had been there ever since. He believed she was the only one who ever had been there, and she was the proprietress of the hotel. Delagoa fever had been mentioned, and he might say that the railway company were now planting eucalyptus trees along the whole line, and it has had the most beneficial effect in reducing fever in that locality. Reference had also been made to the thrifty and industrious natives in connection with immigration into Bechuanaland; but he could only say that if there were any thrifty and industrious natives—although he had travelled through the country a good deal—he had never met with them. The reader of the paper had also referred to the cause of the Kaffir war of 1878. It was generally allowed now by Cape Colonists, who were best able to judge on such a point, that the great mistake made by the English Government was in attempting to govern the natives of South Africa—not by their own laws, which they had held for centuries—but by forcing our laws and civilisation upon them. Sir Charles Warren said he should be happy to see a large population of Englishmen in the Transvaal. He might say that during the last two years between 20,000 and 30,000 Englishmen had passed into the Transvaal, solely to develop the gold-mining industry there. He was one of the 200 who went there in 1883, and the result of their plodding and "sticking out" had been that they had opened up gold mines which were admitted to be as rich, if not richer than any in the world; and the Transvaal Government, which two years ago was helplessly insolvent, had now a large monthly surplus, and from a population of 20,000 Englishmen drew a revenue of £76,000 in one month alone. What the future of the country would be, it was impossible to say; but there seemed to be no doubt that with the gold and silver of the Transvaal, with coal all over South Africa, from Cape Town up to the Zambesi, with silver and copper mines in Damaraland, and the famous diamond mines in Kimberley, from which in 17 years £22,000,000 worth of diamonds had been sent home, together with the agriculture and grazing, the prospects of the country in the future were as bright as any country could hope for. His own impression was that South Africa was passing through the same stages of development

which America did a hundred years ago. Allowing for the differences in civilisation, improvement in business matters, and the rapid extension of railways, he believed that in 20 or 30 years South Africa would be opened up to such an extent that the next generation would come to look up to it as the country of the future.

Mr. THOMAS CORNISH said he had not had the pleasure of visiting South Africa, but he had been in many other parts of the world, and as an old gold miner in Australia, he could endorse the last speaker's remarks with regard to the value to South Africa of the opening up of the goldfields. No doubt if they had been discovered earlier many difficulties would have been avoided, but he thought both the British Government and the Colonial administrators had been very remiss in not foreseeing more clearly the future prospects of the country. If twenty years ago the British Government had claimed a protectorate over the whole of the country from the Congo on the west, and from Zanzibar on the eastern coast, there would have been no one in the world to say nay except a small Portuguese settlement which could easily have been arranged for. Had that been done, we should now have been in possession of the largest portion of the continent of Africa without let or hindrance. It was a great mistake to let foreign nations step in and take possession of land on both the east and west coast, and so interfere with our settlement of the country. He hoped that those to whom were entrusted the destinies of South Africa would pay especial attention to the development of her mineral resources, for that alone would attract a large population. It was all very well to talk of agriculture and grazing, but that did not attract population like gold mining, and the local government should do all in its power to foster the development of railways between the mineral districts and the seaports.

Mr. W. LASCELLES-SCOTT said the discussion hitherto had turned mainly on the development in the more or less near future of the mineral resources of South Africa, but he would address himself to a source of wealth of an important character, not beneath the surface, but which could be tapped at any moment, though it was only just beginning to attract attention in this country. It had been pointed out in the paper that a great mistake had been made in frightening away the natives, and in so doing we might do further harm besides altering the surface of the country. For some years past he had had a great deal to do with some of the natural vegetable products of the country, one of which, strophanthus—the "*kombé*," or arrow-poison of the natives—promised to rival in certain diseases the position which had been long occupied by the cinchonas in febrile affections. When sixteen years ago Dr. Thomas Fraser, of Edinburgh, made some experiments with the peculiar seeds of this creeper (some of which and the pod in which they were contained Mr. Lascelles-Scott had brought with him, and handed round for inspection), he had no idea what a revolution in certain sections of medical science was likely to be developed under his hand. Dr. Fraser had now studied the therapeutic value of strophanthus so far, that if only a sufficient supply could be obtained, there would be any amount of demand for it. This plant was found in several varieties as an enormous creeper, growing wild both on the eastern and western portions of South Africa, but it was only the despised natives who knew where to find it, and if they were driven away, and they and their plants civilised off the surface of the earth, future generations might be deprived of products the value of which it was difficult to estimate. A new treatment of heart diseases had been opened up by the discovery of the glucoside principle, strophanthin, found in these tiny seeds. Again, only a few weeks ago, he had handed to him by an English lady, for some years resident at Delagoa Bay—not the lady who had been described as the only one there—a small sample of a peculiar root-bark, said, on native authority, to possess wonderful properties in the cure of dysentery, which was so fatal throughout equatorial regions. He had only a few grains, just enough to enable him to say that it was chemically very powerful. It was obtained with much difficulty, because there was a certain amount of shyness on such matters amongst the natives, which, unfortunately, the English seemed to develop. That was only one instance out of many of the harm which might be done by the frightening policy which had been denounced by Sir Charles Warren; and he would suggest that it might be well to open up negotiations with the natives, and let them know that if they brought their plants and drugs, whatever they might be, whether medicines or poisons, money, or the articles they valued far more, would be given for them. Already the trade in strophanthus was so important that some houses were making a good income out of it, and the demand was much greater than the supply.

Mr. JAMES JACKSON remarked that Mr. Cameron had found some fault with the conduct of the British Government in its mode of governing the native population, but he did not think that charge could be justified. He said the great cause of our trouble was endeavouring to govern the natives by laws which were unknown to them, and were uncongenial; but as far as he remembered, the greatest troubles with the natives did not arise with those whom the English attempted to govern, but with those who were not governed at all, such as the Gaikas and Zulus. He was in Delagoa Bay in 1877, when he received great hospitality from a white woman there, but she was not the lady Mr. Cameron referred to. Another speaker had referred to the *laches* of the

British Government in not having absorbed the whole country from the Zambesi southward; but that was taking rather a hazy view of the doctrine of *meum* and *tuum*. There was an European power which had settlements on the coast long before England could claim anything in South Africa at all. There were Portuguese settlements at Inhambane and Sofala, besides Delagoa Bay, and when England, fully alive to its importance, set up a claim to a part of the last-mentioned place, and went to arbitration about it, she lost it. There was no doubt Delagoa Bay was the most valuable port in South Africa. From that point, rapid communication might be made to the goldfields, and westward from them to the important district of Pretoria. Irrigation might come to be important by-and by, but for the present it was quite a secondary question. Without an enormous increase in the population there would be no use in raising crops by such means, except in exceptional neighbourhoods. What must be looked to at present for increasing the population was the development of the goldfields. That was the source from which Australia derived its prosperity in the first instance; it was the easy jump from a comparatively thin population to a very large one which enabled them to get over their difficulties. As with a man starting in life to make a fortune, the great difficulty was to make the first thousand pounds; after that it was comparatively easy. So if you could get a good nucleus of population, it spread rapidly afterwards. The great difficulty was to make the start, and the goldfields were the thing to do that. From the Transvaal right down to Cape Town gold was now being found everywhere; the last discovery was within fifty miles of Durban, and the reports of the richness of some of the goldfields were almost fabulous. He saw in the South African papers recently that a gentleman who had been manager of an important gold mine in Victoria had been travelling through the Transvaal, and examining carefully all the reefs, and his prophecy was that, not only would those reefs prove very rich, but that in a very short space of time rich alluvial goldfields would be found, and to the attractions afforded by them rather than to the reefs would they have to look for that increase of population which was so desirable.

Mr. H. Trueman Wood said, in reference to the water power, which had been specially mentioned in the paper, he had a letter a short time ago from the promoters of an exhibition which was being prepared in Grahamstown, saying they were specially anxious to get exhibits of machinery for electric lighting, so that they might have an opportunity of showing the people how easy it would be to utilise their water power for public lighting purposes. He hoped this announcement would, through the columns of the *Journal*, come to the knowledge of the makers of electrical appliances.

Sir Brampton Gurdon, C.B., K.C.M.G., said he wished briefly to defend the natives of South Africa against the somewhat sweeping charge that hardly one could be found who was thrifty or industrious. The Basuto tribe at all events had shown considerable evidence of industry, and if the gentleman who spoke so strongly had visited Lovedale and Edendale, he would have seen that if the natives were treated in the right way and educated, they might be made as industrious almost as Englishmen themselves. It was rather difficult to speak of thrift to men who had no object in putting aside money, but in one way they might be said to be thrifty, inasmuch as a native would work hard, and certainly not squander his money until he had money enough to make the only investment he did make, that was to get a wife; and as she afterwards did all his work for him, it was probably as profitable an investment as any. He was quite willing to allow that the South African native was not a very perfect individual, but if he were treated in the right way, not quite so much like a domestic animal, much better results would be obtained. He had been rather scandalised by the want of feeling often shown by white men towards natives. He remembered, at Delagoa Bay, being somewhat indebted to a white man, who sent his boat to meet Sir Evelyn Wood, with whom he was travelling, and himself; and he acknowledged that he had some time previously knocked one of the natives out of the boat, who was drowned. He was tried and found guilty of murder, and was fined 8s., with or without costs he was not sure. Things were certainly not quite so bad as that in any English territory, but still there was a want of respect for native life and native comfort, which, though the colonists did not notice it, was very objectionable to casual visitors. If colonists would do their best to educate the natives, as was done by some of the missions, which reflected the highest credit on those who carried them on, they would repay the pains taken with them, and would be found by no means wanting in either industry or thrift.

The Chairman, after remarking on the interesting character of the paper, said those who had studied the history and geography of South Africa would know that the suggestion made by Mr. Cornish that England should have placed her hand on the whole of South Africa a few years ago, was not very practicable. In the first place, the colony of Cape Town, with a small portion of land surrounding it, was taken from the Dutch, and for many years the colonists were all Dutch. In the course of time, a very important law was introduced, abolishing slavery, which caused a large number of the Dutch population to leave the colony, and trek onwards, first into the Orange Free State, which ultimately placed itself under the protection of the British Government, owing to difficulties with the Bechuanas. Then those who did not like our Government

trekked still farther onwards, and founded the South African Republic, marked on the map as the Transvaal. Later on, when the Transvaal became bankrupt, they again placed themselves under the British protection, but only very reluctantly, and their subsequent repudiation of it was matter of recent history. England had only moved on gradually in South Africa, and it would have been impossible to have placed our hands at once on so large an extent of territory. On the other hand, a great deal more territory had been annexed since the expedition of Sir Charles Warren. With regard to the natives or Boers being thrifty and industrious, or the reverse, very much depended on the amount of land they held. If they had a large quantity of land they took to pastoral pursuits, which gave little trouble; their cattle and sheep increased, and gave them everything they needed, but directly the country became more crowded, they were no longer able to live in this easy way, and had to till the soil. This had been exemplified in the case of the natives of the Transkei country, or Kaffir land. The Fingoes had increased with such rapidity under the British Government, that there was very little room for their flocks and herds, and consequently they settled down to agricultural pursuits, and were the most industrious, thrifty, and quiet people. He fancied that even the Boers, if they found themselves so hemmed in for want of land that they could not live entirely on their flocks, would take to agricultural employment very much as their ancestors in Holland had done. As Mr. Jackson had remarked, the most important requirement was markets. He had been over many parts of South Africa, and on asking the people what they did with their milk, butter, and so on, they said it was no use making more than they wanted, for they could not sell it, as the distances were too great. If there were a large centre of population, such as the gold or diamond fields might bring about, it would follow that all the neighbourhood round would find a large market, and the country would become more valuable. He concluded by moving a cordial vote of thanks to Sir Charles Warren for his valuable paper, which was carried unanimously.

SECTION OF APPLIED ART.

Tuesday, April 26, 1887; Col. DONNELLY, R.E., C.B., Vice-President of the Society, in the chair.

The paper read was—

DECORATIVE GLASS.

By JOHN HUNGERFORD POLLEN.

The remarks I have the honour to lay before you, ladies and gentlemen, this evening, are descriptive of a beautiful and fairy-like art. I call it fairy-like, not only because of the delicacy and beauty of the material used, but because of the simplicity of its manipulation, and the rapidity with which its most attractive creations are effected.

Glass is transparent as water, and, like the drops and jets of water, threads of it are crystallised into jewelled forms by the action of the air; and, again, light, brittle, and destructible as glass vessels are, they are yet capable of out-lasting many, if not most, of the substances out of which vessels can be made for our use.

1. Before proceeding to discuss the manipulation of our material, it will be necessary to show how it is made. Glass, says the late Professor Barff,* appears to be a mixture of silicates. The material is principally sand, with an alkaline substance, either a salt of soda or potash and lime; though in some kinds of glass oxide of lead takes the place of lime. The scientific name for sand, or, rather, its principal constituent, is silica. This compound oxide of silicon, or silicic acid, when brought into contact with bodies of an opposite character, under suitable conditions unites with them and forms a salt. Now, silicic acid, at the ordinary temperature of the air, has no action whatever on carbonate of soda, but when heated sufficiently, the action becomes vigorous. When sand is mixed with oxide of lead (common litharge), they unite, forming a compound similar to that produced by the silica united with the soda. In one case a soda glass is formed, in the other a lead glass; the former is made with coarser or finer sand, according to what is to be made from it, such as common bottles, crown, sheet or plate glass. The latter kind is called flint glass, and is used for the finer works of the glass-blower—glasses, table decanters and glasses, and imitation jewels. It is more brilliant, colourless, and transparent; it is also considerably heavier than window glass.

2. In putting together the materials for glass-making of the finer kind, it is of great importance that the sand should be as free as possible from impurities. The Venetian furnaces are said to have been supplied from the coast of Syria, where the sand had been famed for its excellence from the days of ancient Rome. The sand now used for flint glass is brought from Alum Bay, in the Isle of Wight, and from Fontainebleau, in the latter case at high prices. The principal impurity found in

* British Industries, Glass, &c.

common sand is some form of oxide of iron, which produces a green colour, and the presence of iron is neutralised by adding black oxide of manganese. This reduces the oxide to the state of peroxide. Peroxide produces a yellow hue, and only to a slight degree. It is by no means easy to adjust the quantity of black oxide of manganese to the amount of iron in the sand, and if in excess, a purple colour is produced. Much of the window-glass of ninety years ago is of a purple hue on this account. If rightly proportioned to the iron in the sand, no appreciable colour is imparted by this substance. I believe that at present arsenic is considered, for various reasons, an equally effective and more manageable agent for this purpose than black oxide of manganese. The proportions quoted by Professor Barff for window glass materials are:—Sand, 4; sulphate of soda, 2; lime, about 4-5ths to 1, with a small quantity of carbon as charcoal. For flint glass:—Sand, 3; red lead, 2 to $2\frac{1}{2}$; carbonate of potash, $1\frac{1}{2}$ to $1\frac{2}{3}$, with a little nitre, or saltpetre, as an oxidizing agent. The analysis of Pompeian glass gives:—Sand, 4; soda, 1; lime, $\frac{1}{2}$ (about); and a small quantity of alumina. Here the proportion of soda seems much less, and lead does not enter into the mixture. Different makers vary these proportions, and have mixtures of their own. If soda is in excess there is apt to remain a certain amount of it not properly reduced, and it is gradually dissolved by the action of the weather, making those holes which we see on the outside of some old window glass. Sometimes we see on the surface a delicate film, which, seen in a certain light, is opalescent. This is also noticeable in glass that has been long buried, from the action of salts in the superincumbent earth, and shows that the due proportion of the materials has not been observed, and a perfect union has not resulted. It would be very desirable that careful experiments should be made by chemists, so as to save glass-founders from errors of this kind, as far as they can be made avoidable.

The materials are partially heated together, and are then called fritt. The fritt is afterwards put into glass-pots, made of fire-clay, in the furnace, where they are gradually fused, and fresh fritt is added till the glass is in a doughy state, not too liquid, in which condition it is known as metal. The pots for window glass are uncovered, and the fire passes over them. Those for flint glass are covered over, leaving an opening in front for the use of the blower. A scum which rises to the surface is removed by iron ladles. A small quantity of broken glass is thrown in at intervals to complete the fusion and purify the metal.

3. Various colours are imparted to glass by the mixture of metallic oxides: red, by copper, as well as green and blue, according to the nature of the oxide: blue by cobalt. A beautiful pink is produced by oxide of gold, and, if used in large quantities, a fine red. Oxide of iron produces either green or yellow. Yellow, of various depths, is also produced by silver, but not by melting it with the metal. Oxide of silver is mixed with chalk, or some similar substance, and laid on the glass when cold, and it is then heated to a dull red, and the yellow stain is pale or deep, according to the quantity of oxide used. Red produced by oxide of gold, and copper-red are both coated over clear glass heated and blown into sheets. Purple and black are produced by black oxide of manganese. There are, however, many varieties of hue which are produced in different factories, some, probably, by accidents of the melting. It is of these materials that painted glass is made, but, as glass painting belongs rather to the painter's art, I shall not attempt any discussion of it here. As we see it in old church windows, it is the very romance of mediæval painting, and its special claims depend on the mellowness and beauty of the glass prepared for it.

4. Besides glass coloured in the metal, gold leaf can be laid on glass, etched and coated over with a thin film of glass. Glasses coloured, but more or less opaque, are used in small dies on walls and vaults, for another kind of painting called mosaic. Light is reflected by this kind of painting, but it is transmitted in many hues by painting on coloured glass in windows. The Whitefriars furnaces turn out a peculiar kind of glass, opaque, and having the look of unglazed porcelain, on which designs are drawn and painted with enamel colours, and these paintings are put into muffles (small kilns, which can be gradually heated at will), and burnt in as in window painting. Like mosaic work, it is a kind of decoration applicable to wall surfaces, in which it can be imbedded. I notice it here because this kind of glass is the result of a peculiar process. It may be produced by breaking up glass of the colour required, and fusing it over again. What sort of intensity of heat, or period of time may be required in its fusion, I do not know, but it may be produced in another way. I

shall have to advert presently to the process of annealing, or the very gradual cooling which glass goes through before it is fit for use. Now it seems that glass, when it leaves the furnace, takes a long time for its particles to arrange themselves. If glass vessels have not been properly annealed, they are extremely brittle; they crack easily if hot water is poured into them—more easily the thicker the glass is; the inside heats and expands before the heat has reached the outside. Thin glass is less brittle. But if thick glass has been carefully annealed, it is less liable to such accidents. If, on the other hand, glass is kept at too high a temperature in the annealing furnace and for too long a time, it loses its transparency and becomes crystalline in texture. This process is called devitrification. A kind of porcelain was at one time made of glass in this state, and went by the name of Réaumur's porcelain. Devitrified glass, as it can stand the weather, if painted and if the incorporation of the enamel colours used upon it were thoroughly understood, might, I suppose, be used not only for internal but for external wall decoration as well. As far as I can learn, such a complete incorporation of enamel ornament on glass of whatever kind has not been yet arrived at, the enamel having a liability to wear off the surface, and the process is perhaps still to be examined by practical chemists. So far, then, as to the composition of the various glasses in use.

5. Next, as to its manufacture. I have compared it to the crystallisation of pure water by the action of the air, for it is the breath of the workman that puts life and beauty into the lumps of soft metal that he draws out of the pot. There are several distinct operations in the decorative treatment of glass. It is blown, cast, moulded, stamped, and cut in a variety of ways when cold. The oldest and the simplest process is that of making simple bottles and window glass—which is of various qualities. This is how sheet glass, for instance, is made: the workman takes an iron blow-pipe, from 5 feet to 6 feet long, and from $\frac{3}{4}$ of an inch to 2 inches in diameter, according to the weight of glass he intends to work. He dips this into the glass pot, gathers by a twisting motion a lump of doughy metal at the end of it. He then blows into it till it swells out into a pear shape. He then rolls it on a slab of marble or of smooth iron, called a *marver*, so as to keep the shape and thickness he requires. It is then swung from side to side over a pit till it has drawn itself into a length sometimes of 50 to 60 inches, and has assumed the form of a true cylinder. It is again heated in the furnace. The cool end of the tube is stopped with the finger, and the air expanding within the cylinder bursts the heated end. The workman withdraws it, and while hot rolls it round, and with an iron tool brings the burst part to the diameter of the cylinder. The other end is detached from the blow-pipe by drawing a thread of hot glass round the shoulder, and after removing the hot glass, a cold tool causes it to crack all round. The cylinder is scored down its length internally with a diamond, and placed in a flattening kiln; when soft, it is opened out with wooden tools where the line has been scored; it is then flattened out on the smooth floor of the kiln. Glass so flattened is sometimes polished, and is then one kind of plate glass. Commoner crown glass is made by opening the globe blown by the workman, who then heats it again, and trundles it round till the heated sides of the globe start suddenly round into a great disc, with the thick bull's eye in the middle. These kinds of glass are annealed and cut up for window glass. Plate glass is not blown, but is either ladled or poured on an iron table, which has edges to suit the required thickness of the glass. It is then rolled with iron rollers. When cold, two plates are brought into contact with each other, and the two surfaces ground with sand and water. They are finally polished by machinery, a process formerly done by hand.

6. These may be called elementary operations. Decorative blowing, which is now to be considered, is a more intricate process, for the working of which long training and skill; readiness and confidence, are required. The workman's tools are of the simplest kind. He uses a blow-pipe as described, rough tongs, scissors, with short, broad blades, and compasses, to gauge his work as he goes on. He has a marver to roll his metal on, and a chair, of which the arms are horizontal iron rails, on which his blow-pipe, or his pontee, or solid holding-rod, can be revolved by one hand, acting as a rough and ready turning lathe.

Let us see how he makes one of those elegant glasses which I shall speak of as Venetian glasses, because the Venetians made them two or three centuries ago in such endless variety, and they now form the glory of glass collectors. Here, for instance, is a decorated glass such as I have had the great pleasure of seeing made in the glass-house of

Messrs. Powell, in Whitefriars. Withdrawing, with the blow-pipe, a small lump of not too liquid glass, the workman blows it into a bulb, and the general shape—convex or conical—is given to it. He then takes a fresh piece of glass to make the stem; sits in his chair and keeps revolving his pontee (holding rod) with glass at the end on the arms, as if in a turning lathe. By the use of his tongs he contracts it where he wishes, forming neckings and bosses. If he is working from an original which he wishes to copy, or from a drawing he has prepared, he regulates the measures of his new stem by applying his compass to the drawing and to his work. Glass cools too quickly to allow the modelling of such a stem without reheating the material from time to time. If it has considerable length, he has to keep turning it round in the furnace to avoid its drooping. It is then again brought to the chair, and the lathe action renewed, till this portion of the glass is completed.

Next, an assistant, with a pontee, armed with a dab of hot glass, sticks it to the centre of the bulb, the workman detaches his end of it from his blow-pipe by touching it all round with a wet iron. The pontee, with the bowl of the future glass, is re-heated. The operator trims the edges with a pair of scissors, rolls it on the warmer, and shapes it out with his tongs, turning the bowl of the glass round as he does so. The bowl, or body, has then to be detached from the pontee on which it has been kept, the stem heated and the two attached. If the glass has wings or handles of white or coloured glass, a small lump of the required metal (as the fused glass is called) is brought by an assistant, the modelled glass being kept at a proper heat. The workman takes a pinch of it with his tongs, draws it out to the thinness he requires, sticks it in its position on the glass, draws it out to a thread or ribbon, forms a loop or loops in it, and brings the end down again to the bowl or stem of the vessel. He pinches this ribbon in at intervals, or thinning it out into a thread, he loops it in and out as he wishes. We see, on some old glasses, the wings, head, claws, and feathers of the two-headed Imperial eagle of the German Empire. Many of these devices are highly complicated, and when the rapid rate at which they are necessarily executed, and the lustrous crystalline beauty of the finished vessel and its decorations are considered, there is no violence in the comparison of this beautiful art to the action of the northern wind on the raindrops, and the tender spray of the waterfall. But while these beautiful crystallisations grow dim and disappear when we grasp them, the marvels of the glass-blowers' art may outlast the lives of many generations.

7. I have spoken of clear glass, whether white or coloured, but glass vessels were and are still made by the Venetians, and at Whitefriars and elsewhere, in which opaque white glass is inserted, taking variously shaped filigree patterns, twisted, network, and collected into beads or balls, and similar arrangements in great variety. I shall show you presently in the lantern some examples of this from the South Kensington Museum. This white goes by the Italian name of *latticinio*, or milky. The vessels made in this material are usually striped, that is, made of bands of clear glass, and of glass in which these white lines, variously twisted, are contained. How is this made?

Opaque white, or enamelled white glass, as it is sometimes called, is made by the addition of oxide of tin, and the metal is then drawn out into little sticks called canes, as in these specimens from Whitefriars. To make these into Venetian *latticinio* or filigree, a number of short pieces of cane are arranged at intervals round a jar, and kept, perhaps, in place by a little sand at the bottom, or accommodated to slight flutings inside the vase. A lump of heated glass is then held by the blower just in the middle of the vase. For some time he merely so holds it that it may bring the little canes up to the requisite heat, so that when touched by the heated mass they may adhere to it. He then blows and expands the heated glass till it touches and takes up the white canes. The mass is then heated, drawn out, and rolled on the marver till the canes are flattened and thoroughly incorporated into the sides of the clear glass in the middle; the whole is then coated over with clear glass. This lump is then pulled out and shortened, one man holds it with one hand on the arm of his chair, while another gradually draws it out and twists it. During this process he varies these twists by holding the glass in at intervals, and other clever turns of the hand. The white lines may run round a central white line, inserted previously into the clear glass, or round a coloured one.

When these filigree canes have been twisted and drawn out to the thickness of a quarter of an inch or so, short lengths, perhaps of a series of these compound canes of different

patterns, are themselves incorporated into a fresh centre of clear glass, and blown into a globe or a vase, which then has alternate stripes of filigree and clear glass running up its surface or spirally round it. We see dishes and vases in which the white or coloured lines cross each other, in what we may call engine-turned reticulations. One method of this operation is said to be by blowing a globe of glass out of a piece in which the white has been twisted spirally, and in one direction. The lower half is then pushed up inside the upper, and a reverse set of spiral lines is added, and the glass thus doubled is dealt with to form a vase or dish, but I have never seen this operation performed. Many of the larger glass vases have medallions of coloured glass on their shoulders, or round their sides. This is done by laying a lump of heated glass in the place desired, and stamping it at once as if with a seal on sealing wax. Vases are sometimes made with grotesque animals, such as stags, fishes, or birds within them, or else the glasses themselves are in those shapes. These grotesque forms are said to have been intended for the mysterious pharmacy of the alchemist. The visitor to large museums will see an endless variety of these blown, twisted, and variegated vessels, dishes, bottles, &c., not to speak of the beautiful chandeliers in which the branches are interspersed with stems bearing coloured flowers and crimped leaves. Chandeliers and complicated looking-glass frames are made up of many different parts, the making of which is simple enough when we examine these compositions in detail.

8. I must now advert to a mixture of fragments of coloured glasses welded in the metal state and veined in the manner of marbles, out of which ornamental glass vessels are blown; this is called *schmelz*. Glass is also made to take up minute pieces of gold leaf or of copper, which are incorporated into the mass, and forms a costly-looking material called *avanturine*. Many of the decorative additions to Venetian vases, &c., are made in avanturine glass. Another product of combined pieces of glass consists of sections of cane arranged as stars and flowers, and bedded in clear metal, forming a mosaic. Paper weights, and other masses of this kind of glass, have long been made by the glass-makers of Murano for the European markets.

9. The processes we have been considering are properly the work of glass-blowers, but glass vases have been made in Venice, and still more in Germany, and other northern countries, who borrowed the art of glass-making from the Venetians, with heraldry and other ornament painted on the surfaces with enamel. The colours are made up with some metallic flux, or with glass reduced to powder, which melts, when exposed to a moderate heat, sufficient to heat the surface of the vessel, and becomes incorporated with it.

Cylindrical vases, decorated with enamelled paintings, made in Bohemia, and in various parts of Germany, are to be seen in most collections. Other methods of decorating glass are by moulding, cutting, and engraving. Glass moulding is done by blowing the glass into a mould. Moulds are now made of metal, but I believe it is a question whether in ancient glass, wood was used, or wood coated with some composition. In any case, glass is blown into the mould, till it reaches the sides, and receives the pattern or design prepared for it. The mould, which is hinged in two or more parts, is opened as soon as the glass cools, and the vessel retains its fire polish.

10. Cutting is performed by applying the glass vessel to the edges of a disc of sandstone, with a sharp edge, revolved by a treadle, and on which sand and water are made to trickle. The cuttings are next smoothed on a disc of slate, or some fine stone, and are finally polished on a grinder of cork, with putty made of some product of lead. Facets, stars, and other simple patterns, are made by these means. For more delicate work, a copper disc is employed, not larger than a shilling, or smaller still, and finally, the graver.

Cutting of a fine kind, in elegant designs, is found on many of the Venetian vessels of the 16th and 17th centuries. There are vases in the Kensington Museum, of German-Venetian workmanship, with figures on the surface, etched, apparently, with a diamond, and of the utmost fineness and delicacy.

Venetian 17th century looking-glasses are found with figures cut on the backs, which are left rough and show like dead silver. When certain designs, such as scrolls, foliage, and the like are polished as well, and in all their parts they add an extraordinary delicacy and lustre to the glass or vessel on which we find them, and impart to it some of the charm which belongs to cut and polished rock crystal. So far, then, as to the general operations of the art now under discussion.

11. Considering, next, the knowledge of

chemistry, and the connection of that science with the making of glass itself, one would be inclined, at first sight, to say that glass can only be the product of a scientific age. As a science, chemistry is of comparatively modern growth. Yet glass-making has a far reaching history. In many respects the composition of the material, and certainly its artistic treatment, has been carried further by the ancients than by ourselves. The antiquity of glass is proved both by paintings in the ancient tombs of Egypt of the 4th dynasty between 3,000 and 4,000 years old, and by specimens still sound and entire, which have been recovered from them, and can be seen in the British and other museums. Whether Egypt is the country of its actual invention is disputed. The Romans claimed it as an accidental discovery of Phœnician traders. As a fact, the art was carried from Egypt to Syria; to Sicily; round the Mediterranean, to Asiatic Greece; and, finally, to Rome. Alexandria continued, for a long period, a principal seat of the manufacture. Tyre was another. It was established on Monte Cœlio, in Rome, and elsewhere in Italy, in the time of the early Cæsars, and the beautiful coloured drinking cups, then made or imported, were highly valued by them. A story is told of a maker who, when the Emperor Tiberius spoke of the fragility of his wares, dashed down, or let us suppose let fall, a glass cup, which was uninjured by the action. It is conceivable that the process of making unbreakable glass, as now practised, may have been known in those days.

12. Among the productions of Egyptian glass makers must be reckoned that of artificial precious stones. Some of them were of an astonishing size:—A statue of Serapis, 13 feet high, of emerald; an emerald given to a Pharoah by a Babylonian king, 6 feet by 4 feet, in this case of Asiatic manufacture. Some large pieces survived those ancient times, and are still surviving in church treasuries, which were believed to be colossal emeralds in the Middle Ages, and were highly valued accordingly. We hear of a table made of a single emerald, found by the Arab conquerors of Spain.* The colours of such slabs, or blocks, of this material as are now extant, are of extraordinary richness and beauty.

The Kensington Museum possesses a number of dishes, vases, bottles, and fragments of green, amber, amber brown, sapphire blue, and schmelz of great beauty. The canes, of which the mixed glass vases contain sections, are twisted and rolled together in the manner described, as regards Venetian glass, but far surpass such examples as I have seen. They can scarcely be represented by photography. The light must be seen through them and on them, in order to the full appreciation of their splendour.

13. The Romans were luxurious and costly in the decoration of their houses, especially of their dining-rooms, in which the important business of the day was carried on. They devoted much splendour to the ceilings of these rooms, which were panelled and coffered in various ways, and the enclosed spaces were gilt and inlaid, among other materials, with little decorative mouldings of coloured glasses. There are fragments of sapphire blue moulded glass decoration at Kensington which seem to have been made for this purpose.

14. Among the more costly glass productions of ancient times we must reckon dishes and vases, cut, like cameos, from coloured glasses coated with opaque white glass, the parts not required for the design being cut down to the translucent ground. The Portland vase in the British Museum is a beautiful example. A vase of two colours of glass, one opalescent, the designs in high relief, was exhibited at Kensington some years ago by a member of the Rothschild family. There is a fragment of a figure, the drapery only, modelled in very low relief on blue ground, at Kensington. The drapery shows that the entire figure must have been nearly a foot high.

15. Sefer Nameh, an Oriental traveller, who wrote a journal between 1035 and 1042, speaks of green glass, made in the suburbs of Cairo, in his day, and of furnaces at Tripoli and elsewhere on the Syrian coast. Of Oriental glass, the most noteworthy examples that can be referred to are the lamps formerly hung in the Arab mosques of Cairo and other cities. Indeed, few more beautiful examples of decorative glass can be seen anywhere. They are in the form of bowls on flat stands with wide funnel-shaped necks, and loops on the shoulders for suspension. They appear to have been made of common glass. In the structure of it you observe specks and bubbles, and they have a horny look, perhaps from their age and the constant presence of oil about them. The decoration consists of bands of red or blue enamel colour, and legenda written

* "Ancient and Modern Furniture," lxii.

in fine Arabic characters, clear glass on the coloured bands and *vice-versâ*. These legends express pious ejaculations, quotations from the Koran, and the names of reigning princes or donors. There are several examples of these lamps at Kensington, and some of small size of other shapes. A large collection has been made at Cairo, and some of those examples were lent at one time for exhibition at Kensington. The glass houses of Alexandria, Tyre, and other Mediterranean cities, turned out these beautiful lamps during the 14th and 15th centuries. But they were made also in Venice to order during the same period. The Persians were the chief customers. Persian workmen were possessed of extraordinary skill in repairing broken glass, but were not successful in making these lamps for themselves. Persian glass vases and *mille fiori* work of great beauty will be seen in the South Kensington Museum.

16. The ancient Roman industries, and the best artists of the 4th century, were transplanted bodily by Constantine to his new capital Constantinople, and it was from the Greeks of the Eastern Empire that the glass-makers' art was reeovered in the Middle Ages, when Italy emerged from the ruin of barbarous invasions. The Venetian islands offered a refuge for such refugees from the mainland as they could support. It is claimed by Venetian annalists, and I incline to believe justly, that this glass industry has been preserved by the Republic, even from Roman times. However that may be, it seems to be from the Greek artists who were received in Venice after the sack of Constantinople, at the beginning of the 13th century, that the finer treatment of glass took its renewed traditions. This industry grew and prospered. Two centuries later, the Eastern Empire was overthrown, and a more general immigration of artists and learned men took place into Western Europe. It is from this time that the Venetians encouraged the manufacture not only of beads and imitation jewels but fine glasses and vases. The island of Murano became the chief seat of the glass-houses of the Republic. Severe laws were passed forbidding the emigration of skilled workmen, and a sort of home rule was granted to the little island, and many social privileges were conferred on the leading members of the guild, or craft. We have already spoken of the kind of work produced. When the fashion of cut-glass came in, during the last century, Venetian glass-making declined.

17. German princes and governments took great pains during the 16th and 17th centuries to introduce Venetian glass-work within their own borders. Workmen were enticed and smuggled into these States, and some fine blown glass vessels were made in various countries. It has been maintained that the fine Venetian pieces on which the Imperial eagle, and other German insignia, are worked, must be of German origin; but, as glass was made for half the princes and noblemen of Europe, in Venice—in many cases to special order, in others, as diplomatic presents from the Government; we ought, I believe, to credit examples of this kind to the makers of Murano. It is true, however, that in Germany and Flanders, Venetian vases and glasses, more or less decorated, were produced, but the very finest examples were probably imported. As regards German 17th century glass, heraldry, and inscriptions in enamel painting, or engraving, form its chief decoration.

The Government of Louis XIV took as much pains to smuggle glass-makers into France as it did for lace-making, and other highly skilled industries. Fine examples of cut-glass chandeliers, looking-glasses, blown glasses, and other old French glass work, are still to be met with.

18. As regards our own country, the making of common window glass was active from the 7th century. By the middle of the 16th it was established at Crutched Friars. In 1673, the Duke of Buckingham brought Venetian workmen over, and settled them in Lambeth. Their principal work was making mirrors of cast or flatted glass, with slightly bevilled edges; and carriage windows. Such bevilled glass was used for glazing the royal palaces and costly houses. Panes of it (of the 17th and early 18th centuries) can be seen now in the sashes of Wren's portion of Hampton Court. Wine bottles, to judge from an old one in our possession, were squat bulbous quarts, with the family crest stamped on the shoulder, wine being imported and bottled at home. The glass industry was for a time protected by State bounties.

The last century saw the end of many declining local industries. Twenty years of war ruined a vast number of porcelain, glass, and other establishments. England had fine potteries still, and exported these wares to the north of Europe and to the south. It is to be met with in Germany and Holland, and in Spain, but decorated glass was confined to

cut table glass, chandeliers, and other work, of which cutting is the chief ornament. Such chandeliers were to be seen in all theatres, halls, and ball-rooms. The material was clear and lustrous, the prismatic pendants and hanging chains, brilliant and effective, though not equal to the earlier productions of France. The brilliancy of these chandeliers goes far to redeem their weight and troublesomeness in cleaning. So, too, of table glass; but its great weight is a serious disadvantage, and its decoration is merely mechanical.

19. Great pains have been taken for some years past by our London, and other manufacturers, both with the crystalline and brilliant quality of their flint glass, and in the manufacture of coloured glasses. A great impulse for the latter was given by the revival in France, and still more, and even passionately, in England, of mediæval art. Church restorations, at the expense of the Government in the former country, and by private persons in our own, led to the cultivation of glass painting, almost a lost art till of recent years. Willement and Gerente, are names honourably connected with that movement, and the method of attaining the splendid hues of old window glass has been carefully studied. Commoner, inferior, and less crystalline glass is a better vehicle for colour than flint glass, perhaps a more effective material for Venetian blown work.

Some years ago Sir Henry Layard, Sir William Drake, and others, came forward to try and put new life into the glass works of Murano, They found funds, looked up workmen who still represented the old traditions, and so, under the energetic lead of Dr. Salviati, the decorative glass blowing of Venice has been revivified. All the old methods and many of the elaborate designs of the old artists have been put in practice. These Venetian processes have been carefully followed by some of our own leading glass makers.

Within the last few years some very beautiful cameo glass-cutting has been executed, principally, I believe, by artists in the Stourbridge works. Some very successful examples were shown at Kensington in the Health Exhibition in 1884. There evidently is a hopeful future for this special branch of sculpture.

20. This brings me round to the point from which I started, the art as we see it now in our factories at home and in Venice. Both there and here the aim is the same, to restore the old methods and work them out with the old skill. Modern chemical knowledge ought to put us at an advantage over our ancestors as regards methods and compounds, and to make it clear whether modern furnace heating is better or worse than the former practice. But that rule of thumb which comes from long and unbroken experience is not to be recovered easily or soon. Seeing what accuracy of eye, what delicacy of touch, what grace in the action of the hand, are required for the finer productions of the blowing iron, it may be doubted whether the Italian has not a natural advantage over our northern workers. Joints and muscles matured under a southern sun are more supple and elastic than the hardier and stronger arms of the colder latitudes. But the feeling and spirit that inspires the artist emanate not from his fingers, but from his mind. I have no desire to enter on the thorny path of abstract principles regarding this or other arts. Too much has been said on that head, and said a great deal too often. I prefer to speak of the art of glass-making, so pure, so fresh, so luminous in its creations as a tradition, with some 3,000 years or thereabouts, at its back. Though the Venetians threw themselves into the Greek traditions as they came down to them, I have little doubt but that they pushed the art of blowing and manipulating fused glass beyond any perfection attained by the Greeks of Byzantium, perhaps by the ancient Greeks; but of that we have not sufficient ground for judging. They do not, however, seem to me to have come near the ancients in compounding those precious materials imitative of emerald and other costly crystals, out of which were made the cups and bowls to which I have already referred. I think this is a kind of perfection from which the Venetians, and we ourselves, are still far removed. So we still are from such sculpture as we see in the Portland vase.

21. Now for a word or two as to our modern English-Venetian and as to modern Venice-Venetian blown work. Much of it is of great beauty, and where decorations of coloured glass and avanturine are employed, it is skilfully done. But comparing it with 16th century work, we are struck by a glaring and over-showy look about it, and an absence of refinement. What we call good taste in art is a delicate and instinctive appreciation of the suitableness, the propriety, and fitness of decoration, which accord with the natural limitations of the material employed. A glass, or a vase, is set off by a certain amount of ornamental detail of coloured glass, or

of other decoration. But the colour should be sparingly used, and should not be of many, very generally not of two, colours. The coloured parts are like jewellery on a lady's neck. We must not ask her to suspend it from her nose as well as her ears, or load her with many coloured varieties. Each addition will detract from the value of those already hung. Avanturine, again, is a gold glass, or passes for it. This material, so valuable in appearance, must not be, as it too often is, in such proportions as to lose its decorative value. As to cut glass, chandeliers and table glass so decorated have a splendour of their own. But what are we to say to a huge throne, a sort of *tour de force* made of vast masses of moulded and polished glass; or to fountains, such as I have seen in some of our vast international exhibitions? I doubt whether any absolute novelties are in store for us in this branch of human industry. But lost ground we have still much to recover. The bane of modern artistic industries is the popular demand for a novelty, even though a novelty should be monstrous.

Shall we ever make again those masses of splendid material, jewel-like in colour, containing something like crystalline light within them, and those colours not only the primary and secondary colours of the Middle Ages, which indeed we already have, but those, tertiary colours which the ancients contrived to reach?

Every generation has some qualities of mind which are its own, every nation has its natural aptitudes and aspirations. By these the traditions of art, and more especially of artistic industries, take a definite character if genuinely carried out. We read it on the surface of the production of ages and of nations, and when we see it we say this or that piece of work is of such and such a time and country. If we are faithful to the laws which trained the artists of older days, we shall acquire confidence, and become artists in our turn. Our work will be thorough, and have new life in it, though our ways will be old ways still.

[The paper was illustrated by photographs of a series of glass objects thrown on the screen by the oxy-hydrogen lantern. A collection of ornamental glass and glassmakers' tools were kindly lent by Messrs. Powell, of the Whitefriars Works. Some drawings of Arab glass mosque lamps, from Cairo, were also lent by the Science and Art Department.]

The CHAIRMAN, in proposing a vote of thanks to Mr. Pollen, said he would not venture to intrude any remarks of his own upon the meeting. The only point on which he would say a word was with reference to a set of prizes which had originated out of the work of the Applied Art Section. When the subject of having these papers on applied art was discussed by the Council of the Society, he suggested that they should also revive the scheme of offering prizes to art workmen in various branches, and he was happy to say that the Council had just decided to devote £250 to this purpose, and the particulars of the scheme would appear in the next number of the *Journal*. Amongst them would be found glass painting and glass blowing. He would only add that these prizes were offered specifically to the workmen themselves. The manufacturer or employer might send in the articles to the Society, but they would only be received on condition that the name of the actual workman was attached to them, and if a prize were awarded, the money prize would go to the workman, and a certificate to the employer. The Council trusted that in this way they would be able to aid in the improvement of the various branches of technical art selected, and especially to encourage intelligent and able workmen. He was sure all would join in a hearty vote of thanks to Mr. Pollen for his very interesting paper.

The vote of thanks was carried unanimously, and the meeting adjourned.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 27th, 1887; SIR SAUL SAMUEL, K.C.M.G., C.B., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Stanton, Arthur Gwyer, 13, Rood-lane, E.C.
Stewart, Major-General John Shaw, United Service Club, S.W.

The following candidates were balloted for and duly elected members of the Society.

Bewley, Thomas Arthur, Port of Dublin Ship-yard, Dublin.
Hill, Henry, The Brewery, Southwark-bridge-road, S.E.
Humphries, John, 695, Holloway-road, N.
King, William David, Lynwood, Waverley-road, Southsea, Hants.
Power, Henry, F.R.C.S., 37A, Great Cumberland-place, W.
Rosher, Charles Henry, 22, Charing-cross, S.W.

The paper read was—

SAVING LIFE AT FIRES.

By Arthur W. C. Shean.

In the endeavour to place before you an account of the various methods adopted or proposed for the security of life jeopardised by fire, I will, as far as possible, confine my remarks strictly to this portion of the subject. The domestic causes of fire, if I may so term them, that so imperil life, I shall, however, summarise, as in the treatment of this subject prevention will be acknowledged preferable to cure.

In treating of life-saving appliances, it is also necessary I should say something of those whose duty it is to use them. The fire service of this country may be roughly estimated to number 50,000 men, divided into 3,000 fire brigades, or similar organisations. The services of about 5,000 men are permanently retained, or, in other words, these men are the servants of a Corporation or public Board, such as exists in London, Liverpool, Manchester, Birmingham, Glasgow, Edinburgh, Dublin, Belfast, and some other cities and towns. About 20,000 firemen are partially retained—that is to say, that, whilst following a trade or profession, their services when called upon are at the disposal of some corporate or other official body, for duty at fires. The purely volunteer firemen of the United Kingdom number about 25,000, and their organisations entirely depend on voluntary subscriptions to defray actual expenses, the chief officer, or captain, usually having the honour of meeting any pecuniary deficiency.

Firemen of every class throughout the kingdom are exempt from State-enforced discipline. The engagement of a fireman is a civil contract, such as exists between any ordinary master and servant.

Abroad, firemen form part of the military force of the country, and are therefore under discipline which the laws of the country enforce. Firemen abroad are recognised, therefore, and much favour is shown them by the State. They take part in all national celebrations and festivities, and are given the place of honour on most occasions, whilst death on fire duty is thought as honourable and meritorious as death on the battlefield, and equal respect is paid to the remains of the hero.

In this country no official recognition is ever paid to the fire force, and, excepting the public funeral of Mr. Braidwood, and a decoration given to the Chief of the London Fire Brigade, no fireman throughout the kingdom has ever been noticed in any way. I must not forget to say, however, that Superintendent Moorman, of the Hampton Court Palace Fire Brigade, did receive a letter of thanks from her Majesty the Queen, in consequence of his brigade having twice saved that historic palace from total destruction by fire.

It frequently happens that a fireman killed on duty leaves a widow and young family. To save them from the workhouse or starvation some fire brigades, like the London Brigade, have a fund to which the men all subscribe. Such means are frequently most inadequate for the purpose, and the death of a fireman generally entails upon his family the direst distress and misery. It is almost impossible for firemen to make adequate provision for such emergencies. An ordinary qualified fireman is paid from 22s. to 35s. a week. Retained firemen are paid £5 to £10 a year, whilst volunteer firemen are usually mechanics or artisans engaged in occupations of a not very remunerative character. This condition of things has given rise to various fraudulent methods for obtaining public money. Bogus societies for presumably charitable purposes connected with firemen start and prosper with marvellous success. It is, therefore, most necessary that the public should exercise particular caution in subscribing to any fund connected with the Fire Brigade service—and on no account whatever should they give to any collector making a house-to-house visit. The mayor, or other civic or recognised authority, or the appointed chief officer of a *bonâ-fide* fire brigade, are the persons to whom only should donations be made. So far has deception been carried, that men dressed up as firemen, and using the name of the Fire Brigade, have collected considerable sums of money.

The training of firemen generally is very imperfect, though their devotion to their work leaves nothing to be desired; and, taking into consideration the fact that in the cause they undertake they have everything to lose, and at best a medal of a private society to gain, excepting the gratification of rendering aid to their fellow men in the time of need, it says much for the *esprit de corps* of the fire service, that their conduct generally is such as it is. Having worked with all classes of firemen, paid, retained, and volunteer, I can find nothing to say but of praise and admiration

at the devotion shown by all ranks in the discharge of their duties, often more trying than fall to the lot of any other service in the country.

I will now pass on to the most frequent causes of fires, that may be easily guarded against. Cheap spirit lamps, paraffin especially, under its numerous *aliases*, are continually the cause of accidents. Easily upset, and creating at once an immense sheet of flame, they may be reckoned amongst the most dangerous of household goods. Failure of water in hydraulic gas chandeliers (those with weights attached, which pull down or go up as required), is a danger in almost every house. Occasionally it should be seen whether the cup, to which the chains and weights are attached, is full of water, and if not, the cup should be filled. The heat in summer weather causes the water to evaporate more quickly, and a good precaution, after nearly filling the cup, is to pour on the top of the water a little oil. Leaving a large fire burning in an empty room, without the precaution of previously fixing on a wire-guard; is dangerous, a little slate in the coal causes an explosion, and a piece of red-hot coal alighting on an ignitable article, has often proved the occasion of a fire. Leaving ignitable articles to dry, or "air" as it is styled, without attention, and children playing by an unguarded grate, are rife sources of danger. Cheap and common matches, the habit of smoking and reading in bed, with a candle close to the bedclothes, ignitable curtains close to a gas bracket, and placing lumps of burning coal on the hearth, account for numerous accidents.

It is not advisable to turn off the gas at the meter at night time. A burner not turned off, on the gas being again turned on at the meter, occasions an escape of gas, which sought for with a light causes an explosion; whereas, by not turning the gas off at the meter, a burner not turned off will simply continue to burn, and consequently draw attention to itself. All inflammable materials close to lights may easily be rendered non-combustible by being dipped in a solution of alum or tungstate of soda. Where stables adjoin dwelling-houses, particular attention should be directed to the use of lights, smoking by grooms or stablemen, &c. On leaving a room after extinguishing the lights, by re-entering it in total darkness, a careful inspection would at once discover a spark or particle of burning substance.

Domestic animals, especially cats, should not be left alone in a room where food may be exposed on a table lit by a lamp or candles standing thereon. An animal, in jumping on the table to seize the food, frequently has upset the light and caused a fire. During an exceptionally hot summer, old country houses, barns, and outhouses built of wood, should have the roof whitened with whiting and size, rendering the effect of the sun less dangerous.

The construction of buildings is a subject too comprehensive to be dealt with in conjunction with the present paper. It is, however, necessary to say something of the buildings from which life is to be rescued by the fire escape. One of the difficulties in the construction of the fire-escape is its adaptability equally to a high and a low building. The height to which modern buildings are now carried more than ever perplexes the mind of the fireman in the consideration of the best means to adopt for the rescue of life. Abroad the subject of fire is considered by the builder, and ladders are more for the use of the firemen in extinguishing the fire than in saving life. The houses are mostly constructed with two staircases. In London and its suburbs "fire" is treated as the most unlikely of all dangers to be encountered, and hence the large annual death roll of lives lost by it I purpose touching on the subject of "construction" of houses only so far as is absolutely necessary in the question of saving life. In the first place a so-called "fire-proof" house is an absurdity—there is nothing absolutely fire-proof. A building may be made to resist fire, but only for a time. Balconies running from house to house are the safest fire escapes; double staircases each side of a solid brick division wall; trap-doors in the roof, and the possibility of transit along the roofs from one house to another; these are what might be termed the natural methods of safety from fire; but methods totally ignored. In London, and especially in the suburbs, there is almost a total absence of trap-doors in the roofs; the gradient of the roofs renders passage along them an impossibility, whilst the materials with which the so-called "houses" are constructed are such as fall the readiest prey to the ravages of fire. As a consequence, life, when jeopardised by fire, can only be saved by the artificial means of ladders from the outside of the house, and at an altitude which a few generations ago would have been deemed almost impossible of attainment. Notwithstanding the absolute need of fire-escapes, as evinced by the already large number nightly

stationed throughout London, it may be noted as a curious fact that there is not, at the present time, and never has been, anyone who was solely and actually a fire-escape builder. Fire-escapes have been built generally by wheelwrights, van and coach builders, fire-engine makers, and the like, but their production has never been the sole business of one man or firm.

Inventors have been few and far between, public encouragement *nil*, and consequently, improvements in fire-escapes have not received in the past the attention from ingenious mechanics or manufacturers that has been devoted to appliances of a far less important character. Seeing that in London alone there are over five millions of human beings who nightly retire to rest, a very large proportion absolutely dependent on the fire escape as their only means of avoiding possible death by fire, it is incredible that no encouragement should be given to improving the means of rescue from fire. But who expects a fire, and who ever dreams of requiring the services of a fire escape or fireman? Whilst a fire is in progress, or within, say, a week of the occurrence of some exceptionally fearful catastrophe, a consensus of sympathy, good advice, and publicly - expressed resolutions to improve matters will find expression; but a little time, and all cools down again, and the same old style, the same old jog trot carries us to the next scare. Money wasted in millions, squandered in millions, in many public services, never finds its way to firemen, or fire brigade appliances. Look at a year's loss by fire, the expenditure of a fiftieth part of which might, most probably, have rendered such ravages by fire an impossibility. The one bone of contention is expense, and not how life can be saved from fire. The real question with all entrusted with the matter is, how little money can we spend, and with that little how can we possibly make the biggest show and appearance.

Long immunity from a fatal fire soon causes absolute disregard of possibilities. The question of providing efficient fire-escapes in many of our large towns has, to the present day, scarcely been considered, and in many places an area of several square miles of houses has probably but one fire-escape for its hundreds of thousands of lives. On every occasion of a fire-escape arriving too late to be of use, the plain unmistakeable fact is disclosed that more are required to give adequate protection. No law or definite rules can be laid down in the rescue of human life from fire. No two fires are alike. In London hardly two buildings are alike, the inhabitants of each house vary, the part of the house on fire varies, the occupants may be up or in bed, awake or asleep, the building may be a lecture hall, a manufactory, a lunatic asylum, or a sweetstuff shop; the fire may have made little progress, or may only be approached at imminent risk. A great deal depends on the coolness and promptitude, fearlessness, and activity of the fireman in charge at the fire, as also to the amount of training and instruction he may have received in the working of the fire-escape under his control. If all fires were alike, and the persons in danger were to be rescued under the same circumstances there would be no difficulty in making a fire-escape to meet every emergency.

Fire-escapes are useful in the subjugation of fire as well as to rescue life—by this means firemen reach neighbouring points of advantage. A fire-escape must be most substantially built in order to carry the weight of several persons, it must also be light in order to enable it to be conveyed rapidly to the scene of a fire.

It was soon after the fire of London, in 1666, that fire-engines were invented by Vander Heyden, and the City was divided into four quarters for the better protection against fire. Each quarter was furnished with 800 leather buckets, fifty ladders, and two hand squirts of brass for each parish, and each ward was ordered to provide a bellman to walk through the ward from 10 o'clock at night till 5 o'clock in the morning to give alarm in case of fire. The fire watch was established in November, 1791, and hand fire-engines came into use in 1832. Mr. Braithwaite invented a steam fire-engine in 1830-32, and the patent land steam fire-engines were adopted in London in 1860. Fire-escapes appear to have first been brought out by a Mr. Davis, in 1809. In 1829, Mr. Abraham Wivell brought his first fire-escape under public notice. In 1837, Mr. Wivell invented a fire-escape to run on wheels, which he afterwards patented. Wivell's patent escapes were adopted by the Royal Society for the Protection of Life from Fire, and were placed in various parts of London by that Association. The pattern of fire escapes invented by Wivell remains to the present day in fire-escapes to be seen in the public streets. Wivell, who may, therefore, be regarded as the first real inventor of the fire-escape, appears to have met a

similar fate to that shared by all who have ever ventured to invent fire appliances, for he died in St. Pancras Workhouse. The first body to take up the question of the safety of life from fire, it will be seen, was the Royal Society for the Protection of Life from Fire, and by the kindness and courtesy of Mr. Cook, who has placed the entire records of the society at my disposal, I am able to trace, from the earliest time, the means for saving life from fire, with the different inventions and improvements that have been made, down to the present day. The Royal Society for the Protection of Life from Fire was established in 1836, in consequence of the excitement caused by the melancholy loss of life at a fire in Tottenham-court-road. It was then a matter of considerable surprise, to thinking and humane persons, that so little had hitherto been attempted for the preservation of life from one of the most dreadful deaths to which a human being is liable, none being exempt, whether in the most exalted, or the more humble, walks of society. In the first page of the society's books we read:—"Who does not recoil with horror from the idea of the dreadful catastrophe of a father, a mother, a child, a family, being suddenly enveloped in flames, without the possibility of escape?" On the 2nd October, 1843, the society had nine fire-escapes stationed in London. The first pamphlet issued by the society bears date September 25, 1843. For maintaining an organised body of men provided with and instructed in the use of public fire-escapes, kept in readiness at various convenient stations throughout the metropolis, and rewarding all persons instrumental in saving life from fire, the cash statement, September, 1843, to March, 1844, shows an expenditure of £456. In the 1844-5 report, 80 fires had been attended by the various conductors, at several of which they had proved the means of escape to the inmates of the houses on fire. A great obstacle stated is the first cost of an escape—about £50, and the hope of the society is expressed, that it may eventually provide an escape and conductor at intervals of five minutes' call from each other throughout the metropolis. The receipts of the society in 1845 amounted to £968, and in 1848 to £1,826. There is an address in the 1847 report which says:—"The first attempt in 1836 to establish the society proved a failure. Owing to the over zeal and indiscretion of some of its friends the society was run into difficulties, and public confidence in it destroyed; but the cause was good, and finally the society has been extricated from all embarrassments, and its public credit restored by a subsequent period of four years of very great usefulness." In 1847, the escapes stationed by the society numbered 22. In the 1849 report the first drawing of a fire-escape appears, named Davies's Improved Fire Escape. In the 1849 report the following is an abstract of the society's operations in saving life since September, 1843:—In the 15 months ending March 31, 1845, 116 fires attended, 13 lives saved; in the 12 months ending March 31, 1846, 96 fires attended, 7 lives saved; in the 12 months ending March 31, 1847, 139 fires attended, 11 lives saved; in the 12 months ending March 31, 1848, 197 fires attended, 17 lives saved; in the 12 months ending March 31, 1849, 223 fires attended, 31 lives saved. Total in five years and three months (commencing with six fire-escape stations and gradually increasing them to twenty-six), fires attended, 771; lives saved, 79. Every station is stated to cost £70, with an annual cost of £80. The society add, "They strongly feel that to the blessing of God alone every instance of preservation must be attributed, yet that that blessing is not to be expected if the use of the means be neglected." The 1849 cash statement shows an income of £2,079. Wivell's improved fire-escape is next illustrated. It is upon the principle of that adopted by the society previous to its reorganisation in 1848, but greatly improved from time to time, by trying the various suggestions offered by scientific persons, and patiently testing every alteration of its original inventor, the late Mr. Abraham Wivell, whose perseverance and painstaking efforts to obtain a fire-escape adapted for all emergencies cannot be forgotten. The main ladder reaches from 30 ft. to 32 ft., and can instantly be applied to most second-floor windows by means of the carriage lever. The upper ladder folds over the main ladder, by a rope attached to its lower irons, on either side of the main ladder. The short ladder, for first floors, fits under the carriage. The whole length of the main ladder is a canvas trough or bagging, made of stout sail cloth, protected by an outer trough of copper wire net, leaving sufficient room between for the yielding of the canvas in a person's descent. The soaking of the canvas in alum and other solutions is also attended to; but this, while preventing it from flaming, cannot avoid the risk of accident from the fire charring the canvas. The

height attainable by these escapes varies from 41 ft. 6 in. to 45 ft.; the weight of each averages $8\frac{1}{2}$ cwt.; and the cost of building £45, exclusive of a premium of £5, considered by the committee morally due to the inventor, and paid accordingly to the time of his decease.

The Bishopsgate escape had an additional improvement, adapted to render the escape available for the numerous courts abounding in the district. It consisted in effecting the unshipment of the upper ladder, to which the short or first-floor ladder is fitted, the whole length being carried, with a rope and belt attached, where the large escape cannot be used. The King's-cross escape was constructed to take on and off the carriage for application to the gardens of the New-road. This was necessarily without the canvas trough or netting.

Winter and Lane's Patent Balconian Fire Escape is next mentioned as the joint production of several inventors; but the merit of its best parts is claimed by the society's builder, who, after many failures, was enabled to produce a working machine, but widely differing from the original specification. It consisted of sliding ladders; the upper (raised by two ropes, secured to cleats near the lever) has a fixed balcony at top, with a trap-door to admit passage either way. The main ladder stands 38 feet, and has a large but light balcony, travelling upon an iron tramway, let into the ladder; this is capable of being raised by one person, by the side-ropes, to the top of the main ladder, and can hold four persons at a time. It enables assistance to be rendered at a height of 50 feet, costs £55, and weighs $9\frac{1}{4}$ cwt. This fire-escape is the first by which life was saved from fire within the City of London, viz., at the fire in Newgate-street, July 19th, 1846. Davies' Fire Escape is quoted as quite a recent invention, purchased at the request of the inhabitants of the district, and stationed by the Obelisk, in the Blackfriars-road, in June, 1848. It consisted of one ladder, of great strength and durability, from the peculiarly ingenious manner with which it was trussed on the under side with wire ropes. The balcony slides up and down in front of the ladder, by means of a windlass worked from the sides of the carriage by winch handles, controlled by a lever break, and protection is afforded against accident in any unexpected descent of the balcony, by two large vulcanised india-rubber buffers, to receive its weight. A supplemental short ladder is appended under the carriage, as to all the other escapes, and this is made to fit, if need be, to the balcony, so as to command a third floor or roof of the building on fire. The leverage for winding and propelling the escape in an upright position, is similar in design and folds in on the same principle as "Wivell's," with the addition of a step-ladder for convenient descent from the balcony. This escape came into actual use at a fire in August, 1848, in Friar-street, Blackfriars, saving three lives. It cost £45; height attainable, with short ladder joined on, about 42 feet; weight, 9 cwt. The inventor and builder is Mr. D. Davies, carriage builder to the Great Western Railway. Mention of fire-escapes, invented for keeping in dwelling-houses, is made; specially named are Baylis's, Butler's, and Lee's. In 1850, the number of fire-escape stations was increased to 28; 236 fires attended, and 26 lives saved; 38 fires occurring during April and May alone, and 16 lives saved therefrom. In six years and five months, therefore, 1,007 fires were attended, and 105 human beings preserved from death, the time of the fires occurring principally between the hours of 2 and 5 a.m. The stations were visited at uncertain and irregular intervals by inspectors whilst the conductors were on duty. The cash statement, in 1850, shows an income of £2,153, and attached to the report is a list of parochial contributions, voted under authority of the Statute 14 George III., cap. 78, Building Act, the sufficiency of which for the purpose is thus commented upon by Mr. Auditor Gibbs, " . . . Considering the extent of public benefit which will accrue by a liberal interpretation of the statute in this behalf, I am inclined to allow, as an extra charge on the poor rate of each parish, for fire expenses, such competent sum of money as may be deemed by the majority of vestrymen in vestry duly assembled requisite for the ends aforesaid, the order of the vestry to pay, and the receipt for the amount paid, will be the voucher I shall require at the audit." With the exception of this money, the entire funds of the society were voluntary contributions, solicited by collectors. In 1851, the number of escape stations was increased to 30; 226 fires were attended, and 36 lives saved. On the 9th May, 1851, the Lord Mayor presided over the public anniversary meeting of the society, and the treasurer remarked, "Theirs was no company or insurance office, but was promoted solely on benevolent grounds. The services of the committee were

wholly gratuitous, and rendered with the single desire to benefit their fellow creatures; in every respect," he added, "the society was the kindred institution to the Royal Humane Society, the only difference being that the last-named society was for the preservation from that element on which this depended as its most powerful auxiliary." The 1851 cash statement shows an income of £2,240. In 1852, the number of fire-escape stations was increased to 34. Fires attended 253; lives saved 25; cash statement, 1852, shows the income £3,304. In 1853, the escape stations were increased to 40; fires attended 265; lives saved, 46; income £3,665. In the 1853 report appears the first map showing the stations of the fire-escapes. In 1854, 328 fires attended, and 28 lives saved; income £3,172. 1855, escape stations increased to 43; 354 fires attended; 41 lives saved, total income about £4,000. In 1857, the stations increased to 52. In 1858, they increased to 62, and the income to £6,831. In 1859, stations increased to 70; the number of subscribers extending to over 15,000, and income £7,510. In 1860, 72 stations had been established, and the income £8,225. In 1864, mention is made of the proposed new Government Fire Bill. So long as the fire-engines and their brigade formed a voluntarily supported service, without aid or authority of the State, the society could maintain its fire-escape service on an equal footing; but if the former were endowed with the authority of a Government department, nominally as the public provision for the protection of life as well as property, and the fire-escapes of the society left without either a claim on parishes for support or authority with the police for assistance, their efficiency must suffer. In 1864, the income was £10,481. Starting with 6 fire-escapes, the society, in 1865, attained an income of over £10,000, maintained 85 fire-escape stations, 5 inspectors, 89 conductors, and 6 supernumeraries. Mention is made, in the 1866 report, of the possible amalgamation of the fire-escape force, contemplated by the new Fire Bill, with the new Metropolitan Fire Brigade, under the Metropolitan Board of Works. In 1867, the committee of the society terminated their labours by reason of their functions being undertaken by the Metropolitan Board of Works, under the provisions of the Fire Brigade Act, 28 and 29 Vic., and a *resumé* report of their proceedings, since they first took office in 1843, is given, showing a total of 9,299 fires attended, and 1,150 lives saved. The society was called upon by the Act of Parliament to resign their charge, and transfer the society's plant "in unimpaired efficiency." This valuable plant, which certainly could not be replaced under an outlay of £9,000, and for which they might reasonably have required payment from the Board, was, on behalf of the subscribers and the general public, presented to the Metropolitan Board of Works as a gift. £2,000 was set aside by the society as a Life Rescue Reward Fund, and a further sum of £300 to provide any expenses thereon, in order to secure in perpetuity the means of rewarding brave efforts to save human life from fire. £1,025 0s. 1d. was unappropriated, and left subject to any special directions. The thirty-third annual report mentions the extension of the society's operations to the country, and six stations established in the suburban and provincial towns were increased to 17. The escapes were granted under a form of contract entered into by the officers of corporate towns, they engaging to maintain the machinery in thorough efficiency, and ready for service at fires whenever called upon, the escapes remaining the property of the society, and subject to re-call in the event of the conditions of maintenance not being fulfilled. In 1869, £1,086 19s. 1d. was transferred to the reserve fund. In 1870 the society had 23 fire-escapes stationed in the suburbs and the provincial towns. In this year mention is made of the substitution of the copper gauze netting, and the awardof the London Exhibition medals of 1862, and the Paris medal of 1867, to Mr. Clarke, the society's builder, for an escape reaching a height of 80 and 90 feet, at a cost of £80, and including quadrant irons to work the lever of upper ladders upon. In 1870 occurred an accident that raised a most important question respecting fire-escapes—the notable case of the death of fireman Ford, who, after heroically saving five lives at a fire in Gray's-inn-road, lost his own. The death of this man caused such a thrill of sympathy to pervade our fellow countrymen, that money poured in for the benefit of his wife and family from all parts of the kingdom. I must here note that the society, in their 1871 report, state:—"It is a matter of extreme regret that the Society's subscribers have been misled into paying subscriptions intended for the society to one calling itself 'The Disabled Firemen's Relief and Pension Association,' and 'The London and Suburban Volunteer Fire Brigade,' and notwithstanding the public announcements that have been

made respecting this association or brigade, both by the Committee of the Royal Society and the Metropolitan Board of Works, it would appear that subscriptions are still being collected by them." Occasions like the death of poor Ford being utilised by unscrupulous persons to defraud the public, it is most essential that the public should be placed well on their guard. Ford, who was on duty with the Bedford-row fire-escape, proceeded, on being called to the fire, with the utmost speed. On his arrival there were six persons in the third floor front room, five at the left-hand window and one at the right. Placing his escape at the former, he, with great difficulty, and after much exertion, succeeded in getting the five persons out safely; and he was in the act of coming down himself, when he became enveloped in flames and smoke, which burst from the first floor window; and after struggling in the wire netting, he fell to the pavement, being so severely burned and otherwise injured that his recovery was hopeless. The tragic death of Ford led to the first trial of escapes ever held. It was presumed at the time that Ford lost his life through the canvas shoot of the escape catching fire; another account is that his axe caught in the wire netting and held him fast, roasting him in fact till the wire gave way and he fell. Up to this time Wivell's improved fire-escape was still in use, and it was in Wivell's escape poor Ford died. On the Metropolitan Board of Works taking control of the fire-escapes, they commissioned Messrs. E. H. Bayley and Co., of Newington-causeway, S.E., van and carriage builders, by contract, to replace the whole of the 103 escapes then in use. The improvements claimed for Messrs. Bayley's escape are the avoidance of superfluous weight, an improved balance, a maximum of lightness, and an alteration in the carriage which connects the main ladder with the axletree. The main and fly ladders are strengthened by a system of trussing by means of homogeneous steel-wire rope, in such a way as to render an accident impossible. The canvas and gauze or netting shoots which, it is said, impeded the travelling of the escape during windy weather, and are stated to be liable to catch fire, are dispensed with. In place thereof a light but strong shoot entirely of copper is used. It is sufficiently strong to support any weight that can be put upon it. It is incombustible. The levers used for throwing the fly and other ladders are connected in such a way as to facilitate, and prevent them from becoming jammed.

At the inquest on Ford, George Carter, a police-constable, 29 E Reserve, said that he discovered the fire, and saw Ford pitch the escape, and go up and bring down an aged woman, and he went up again and sent down three others. Witness went up the other escape, and he saw Ford hanging to the round of the ladder, but his legs became entangled in the canvas and netting, and the flames rushed over his back.

Experiments made by the society proved the copper gauze to be invaluable as affording almost an entire protection against the canvas burning for a space of four minutes. The canvas also is saturated with silicates as a precaution against the flame lapping round the shoot and igniting it from the front. Mr. Yardley, the society's machinery surveyor, was instructed to have two new escapes built, one by the society, and one by the builder to the Metropolitan Board of Works, and to arrange for a public and competitive trial of both.

On the second day of August, 1872, the trial took place on the Victoria-embankment, and in Whitehall-yard. From the report, the committee felt bound to seek the opinion of a scientific chemist upon the action of heat on different materials. Dr. Attfield, F.C.S., Professor of Practical Chemistry to the Pharmaceutical Society of Great Britain, had the whole question referred to him, and the committee of the society, with the surveyor and secretary, were unanimously of opinion:—

1. As to general construction—

(*a*). That, in rapidity in travelling, the society's escape is equal, if not superior, to any known to exist.

(*b*). That it is as light as it can be made for the purpose of effectively saving life.

(*c*). That it is more handy in all the evolutions to which it was subjected.

2. As to the danger of canvas catching fire, compared with the usefulness of the canvas shoot, the following facts must be recapitulated—

(*a*). The copper gauze as hitherto used, together with the canvas, is not as heavy by, say, 42 lbs., as the copper netting used in the brigade escape. Weight of gauze and canvas in the society's escape, 30 feet high, about 40½ lbs. Weight of copper netting in brigade escape, with canvas hammock at bottom, about 83 lbs. Weight of galvanised iron netting (recommended by Dr. Attfield) with lower 6 feet of canvas, about 58½ lbs.

(*b*). That, looking at the heat to which escapes can be subjected at a building on fire, both copper gauze and netting are practically indestructible by fire.

(*c*). That no object would be served in using copper netting, as galvanised iron netting is equal in strength, more durable, cheaper, and much lighter.

(*d*). That without canvas, galvanised iron netting will add at least 18 lbs. to the society's escape, fitted now with gauze and canvas.

The subject, therefore, narrowed to the following questions:—

1. Whether the canvas shoot shall be done away with, and the galvanised iron netting substituted; or

2. Whether the canvas shoot and gauze should be retained.

If an escape is efficiently handled, the number of times it comes into contact with flame bear a very small proportion to the number of times it is used (as shown by the society's accounts of burnt escapes, extending over more than twenty years); and again, that contact with flame can, in most cases, be avoided by shifting the escape. Further, that in all these occasions, by far the majority, in which there is no liability to the escape coming into contact with flame, the comfort, security, and courage given to the endangered by the use of the canvas shoot not only renders their deliverance more rapid, but they are not liable to be torn or scorched by the netting, nor are they liable to personal hurt by shock—as may happen upon the rapidity of their descent in a shoot without canvas.

The following inquiries were then instituted into the possibility of—

1. Finding a copper gauze more effective in resisting flame.

2. Some chemical solutions to reduce the chances of the canvas being ignited.

3. Whether fine iron gauze, referred to in Dr. Attfield's report, could be made available for escape purposes.

The following are the conclusions from Dr. Attfield's report (dated 21st October, 1872):—

"First, that although certain compounds, carefully incorporated with canvas and vegetable fibres, generally will prevent flame being communicated from one part of such fabric to another, these compounds do not prevent the fabrics from being charred under the action of flame, and in less than half a minute rendered strengthless. Second, that this rapid destruction, for all fire escape purposes, of either prepared or unprepared canvas renders necessary the employment of an outer incombustible casing to a canvas escape shoot, in order that persons passing down such a sack may not fall through a charred portion to the ground beneath. Third, that the outer casing, or copper gauze, now employed in the society's escape affords not the slightest fire protection to the canvas, and would be seriously weakened, and possibly, in places, melted, by the action of a really fierce body of flame. Fourth, that the copper netting forming the shoot of the brigade escapes is not melted, or even materially weakened, by any body of flame likely to issue from a window or similar aperture in the wall of a burning dwelling-house. Fifth, that flames instantly pass into the shoot of a brigade escape, but do not scorch or burn anything in the shoot of a society escape until after some ten or twenty seconds."

Dr. Attfield suggests that if, for reasons which do not concern his inquiry, the retention of canvas shoots is desirable, the gauze envelope of the canvas be of such a degree of fineness that flame cannot pass through it.

This fine gauze should be of iron, not of copper, for fine copper gauze is melted with great readiness by flame, while iron gauze, of similar fineness, cannot be melted by any ordinary flame; indeed, such iron gauze can only be fused, or rather burnt, by a blowpipe flame well fed with air. Such gauze becomes red-hot in a few seconds, when heated by flame, but the latter does not pass through the meshes; hence, any canvas at a distance of about two inches from the gauze is only slightly charred after two minutes by the radiated heat and hot gases, and not charred through and rendered friable until the lapse of about three minutes. Such gauze weighs about three ounces per square foot, and not unfrequently contains 1,000 or 1,200 holes per square inch. The objection to fine iron wire gauze for fire-escape purposes is, that it is extremely liable to become oxidised or rusted by the influence of air and moisture, and, therefore, to be rendered brittle and useless. Hence it would have to be frequently renewed, for it could not be protected by a coating of zinc (galvanised) or other material, as such substances would fill up the interstices of the gauze. To provide a cool pathway through flames for two minutes, or even for twenty seconds, may make all the difference between life and death, or at least between a whole skin and a blistered one. Dr. Attfield considers a great improvement on the brigade escape would be a shoot made of thinner netting than that used, and that the

netting should be not copper but galvanised iron. Iron wire is stronger than copper of the same size in the proportion of about the figures 3 and 2 ; bulk for bulk, iron is lighter than copper in the proportion of $7\frac{3}{4}$ to 9. The melting point of copper being about 2,000° Fahr., iron is considerably over 3,000° Fahr. It is true iron is liable to corrosion (rust), while copper has not this defect; but Dr. Attfield recommends that the iron be coated with zinc —be galvanised iron netting, in short—which greatly retards tendency to rust, and does not appreciably weaken the iron. It is obvious an escape made of such material would possess all the advantages of a brigade escape, while it would be much lighter and inexpensive. The iron netting employed by Dr. Attfield weighed about nine ounces per square foot, and had about nine holes per square inch. Mr. Vincent Yardley, knowing Professor Barff, of the University College, who had bestowed much study on the application of silicates for various purposes, and had found that some of them offered great resistance to fire, applied to that gentleman, who favoured Mr. Yardley valuable suggestions for rendering the canvas uninflammable. After testing the durability of the canvas prepared in such a manner, and exposing it to the weather, by soaking it in water for 48 hours, and when dry again exposing it to the flames, he found that its uninflammable condition was unaltered. Finally, Mr. Yardley recommended the use of copper gauze No. 28 with the prepared canvas, as rendering an escape as perfect as was possible.

A second question, of almost as great importance, was whether the canvas lining to the shoot retarded its speed in travelling to a fire, and in a report, dated 26th January, 1872, Mr. Vincent Yardley says:—

"I measured off a distance of about a quarter of a mile on the Embankment, and started a 'society's' escape and a 'brigade' escape, with two men each, at a given signal, to a point and back, so that any resistance of the air in travelling should be in force one way or the other. The time taken was $3\frac{1}{2}$ minutes for the 'society's' escape, and 4 minutes for the 'brigade' escape. I then reversed the men to the two escapes, in order to equalise any difference of power in those selected, and started them again, when the time taken was 4 minutes 34 seconds for the society's escape, and 5 minutes for the brigade escape, thus showing that the canvas shoot does not present that obstruction to rapidity in travelling in fair weather which has been supposed, though there can be no doubt that when there has been a strong head wind blowing, the result would be different, especially if both escapes were of the same weight; on the other hand, one of the society's escapes running before the wind would be assisted thereby. This trial, it must be added, was carried out by the drill instructor to the brigade, and was followed by several other experiments. The second was running an escape as to a fire, and 'pitching' it against a building. The society's escape arrived on the spot in 1 minute, and the brigade escape in 1 minute 10 seconds, and the man was brought down the former escape about half a minute in advance of the other. The third experiment viz., raising the escape from a horizontal position, and running to the United Service Institution, demonstrated the advantage of lightness in the society's escape over the other, as it was raised easily by four men at the lever only, and run from its position to the supposed fire, in less than one minute, whereas the brigade escape was only raised by the united exertions of five men at the lever, and one to throw up the head of the escape, which, together with the running exactly the same distance to the supposed fire, occupied upwards of four minutes. The fourth experiment, in detaching the fly ladders from the main ladders while the escapes were in a horizontal position, proved favourable to the 'society's' escape. The fifth experiment, testing the efficacy of the mode of trussing the main ladders resulted in showing the greater rigidity of the 'brigade' escape, the deflection being, on the 'brigade' escape, only $1\frac{3}{4}$ inch., while on the 'society's' escape it was $2\frac{5}{8}$ inches. The sixth experiment, a test as to the facility of descent of a person placed in the two different shoots at a similar angle, and the resistance obtained by the friction in each case, was a hardly perceptible difference in the rapidity of descent. The seventh and last experiment, the amount of protection afforded to the human body by each shoot respectively, when the flames were rushing from an intermediate storey of a building, and coming in contact with any portion of the shoot. A cradle filled with wood shavings, with the addition of some oil of petroleum lighted, and over it held a full-sized model representing a portion of the shoot of each escape ; that of the ordinary escape used by the society being composed of the canvas which had been saturated with a known fire-proof solution, and protected on the outside with copper gauze, with a space between the canvas and the gauze ; and that of the escape adopted by the Metropolitan Fire Brigade, of copper netting (No. 16 wire) and meshes $\frac{5}{8}$-inch square, which could not be expected to present the slighest obstruction to the passage of the flames. A dummy made of calico, and filled with shavings, was placed in each model, and subjected to the flames, the first one tried being that of the 'brigade' escape, in which, as anticipated, the dummy was ignited in an inappreciable space of time, while in the model of the canvas shoot, the next submitted to the flames, which had by that

time become so fierce that it was almost impossible to stand within two yards of them, the canvas ignited only after an interval of some twenty seconds, and the dummy was taken out and found to be only slightly scorched, thereby proving that the canvas must necessarily be a greater protection to the human body against the action of fire, especially if protected by a flame-resisting material, than open netting without canvas."

It is stated by the society that the assertion in the report of the Fire Brigade Committee of the Metropolitan Board of Works, on the subject of the fire in Gray's-inn-road, that "The wire gauze is nearly four times as heavy as the wire netting, being 50 lbs. as against 13 lbs.," was erroneous. In conclusion it was found that the fire-escape adopted by the society did not, when severely tested, possess that immunity from destruction by fire, combined with security to the persons to be rescued by it, which had been attributed to it, and which it is most important an escape should possess. On the 30th December, 1879, what may be termed as the winding-up meeting of the society, was held "To distribute the rewards voted in cases of saving life, and to confirm negociations entered into by the committee for the transfer of the funds of the society to the Charity Commissioners, after payment of all outstanding liabilities, and compensating the society's officers and servants for the compulsory abolition of their offices, and to devote the interest of the remaining capital to rewards for saving life. During the latter years of the society's existence they received much valuable help and assistance from the Corporation of London, the meetings being sometimes held at the Mansion-house. While faults may be found with our ancient Corporation, one thing is to be specially noted, and that is, their appreciation and valued support of any really good work.

And thus, so to speak, ended in 1879, the labours, so far as active work in fire-escapes was considered, of a most valuable and meritorious society, most worthy of deep public gratitude and respect. The society continues to make grants of rewards for saving life from fire, to persons who shall have distinguished themselves, or received injury while engaged in the rescue of life from fire. The rewards take the shape of the gift of medals, testimonials, or sums of money, or of grants of money to the parents, widows, or children, in the case of persons whose deaths may have resulted from their endeavours to save life from fire. The society had, up to this time, placed sixty-seven fire escapes at suburban and provincial stations; and, up to the present time the society has investigated upwards of 14,150 cases in which meritorious services have been rendered in rescuing life from fire.

I have endeavoured to bring before you the question of saving life at fires, from the earliest known period to the present day; and in the escape that is now to be seen in London, you see the same design invented by Wivell in 1829—fifty-eight years ago. The average weight of the escapes in use at the present day may be fairly taken at 14 cwt. when complete with all their tackle, the height of the main ladder being about 27 feet, and the total height obtainable about 47 feet. In very windy weather the machine has to be placed in a horizontal position, and at "call" valuable time is of necessity lost in raising it to a perpendicular position in order to run it. I may here state that the raising of an escape by pulley and tackle from a horizontal position by the man standing on the foot-iron of the escape, is made the test of strength to qualify a man for admission to the Fire Brigade. The "pull" necessary to raise the escape is, I should judge, equal to about that of 250 lbs. to 300 lbs. To pass under telegraph wires or low railway arches the machine must be again lowered, and raised after passing the obstruction, a serious impediment, wasting valuable time. The machine is of course liable to be capsized by a gale of wind, or overbalanced by unskillful management. It can be moved by manual labour only, and consequently, in ascending steep gradients much auxiliary help is necessary. After running such a machine to a fire, the conductor has to ascend, and if rescue is to be effected above the height of the main shaft, he must bring each person down the extension ladders on his shoulders. Firemen have a system of picking up people and quickly balancing their bodies across their shoulders, something after the way in which sacks of coal are carried, and in this position they can easily be brought down the ladders. It must not be forgotten, however, that a very considerable expenditure of muscular strength is necessary to run an escape, say, the best part of a mile, throw up the ladders on arrival, ascend, enter a room where breathing is almost an impossibility in consequence of smoke, and then bring the inmates down the ladders, an ascent and descent having to be made for each

person to be rescued. There are an enormous number of houses in London also where the ordinary escape is perfectly useless, by reason of its inability to reach to the top of the building, whilst in the suburbs, high brick walls often render the "pitching" of the escape against the house an impossibility. In many cases, and most notably in the suburbs of London, fire-escapes are miles apart, and life is, therefore, very insecure in the event of fire. In the country, as I stated in the commencement of my paper, one escape has to do duty for an entire town, sometimes of considerable magnitude.

Escapes carry what is called a "jumping sheet," a piece of sail cloth about 10 feet square, having rope handles all round the edges. It is intended to be well held all round, to catch anyone dropping from a window or height, and so break their fall. In most services, take, for instance, the army or navy, there exists amongst certain people rooted prejudice and antipathy to anything new, and also a jealous feeling begotten of supposed rivalry. Thus it is, firemen generally are by no means unanimous in their verdict on either fire-escapes or fire-engines. Smith, in the North, having selected an escape, or engine, considers his choice reflects greater soundness of judgment than that of Jones, of the South, who has chosen an escape, or engine, of a different pattern. Hence, it is much to be regretted the Royal Society for the Protection of Life from Fire, as a body of gentlemen solely interested in promoting the saving of life from fire, has, practically, ceased to exist. An independent jury of educated gentlemen are far better qualified to give an opinion than any official. As will have been noticed, from the earliest build of fire-escapes to the present time, only the most trivial alterations, or improvements, have been effected. At the foot of the shoot, or main ladder, used to be placed a bag of shavings, or other soft substance, to break the fall of the person descending; this has given place to a canvas apron. Some little time ago, a supposed improvement was made, by displacing the springs and resting the carriage of the escape on stout india-rubber blocks. The springs made the escape "ride," as firemen term it, and their displacement was soon found to be detrimental to its running. Anyone pushing a truck with springs and one without will soon become aware of the unpleasant jar of the one compared with the easy going of the other. By far the most valuable improvements of late years is to be found in "Bray's" fire-escape, and they must be acknowledged to be of much practical value. Mr. Bray has considerably improved the "trussing" of ladders, originally devised by Davies, in 1848, and also has patented the best system of raising the ladders telescopically. The contrivance is on the principle of what nautical men know as the "messenger" on board ship, by means of which the anchor is raised. By turning a handle, all the extension ladders are simultaneously raised together, till the maximum height is attained. A saving of manual labour is effected, and the height can be regulated to any given point. With the ordinary escape, the extension ladders being in given lengths, the escape after being "pitched" must be moved, a process entailing some danger if the ladder exceed or fall short of the desired height. There can be no question that the "telescopic" method of raising ladders is a very considerable improvement on the old system. There are, I believe, several means patented for the purpose, but I draw attention to the method adopted by Mr. Bray as being the simplest and apparently the best. I may also refer to other inventions and patents by Messrs. Merryweather and Sons, of Long-acre, and Messrs. Shand, Mason and Co., of Blackfriars, both firms very celebrated fire-engine makers. There are various advantages claimed for each escape, and at the same time there are objections which can be raised. It is not my province to say which escape is the best, but only to endeavour to bring all before you, that their merits and faults may be left for you to judge.

A large number of appliances have been invented for the purposes of aiding escape from a burning house. They may be divided into two classes:—

1. Structural. That is to say, appliances made for permanent attachment to the outside of the house.

2. Portable. Appliances that may be kept in any room, and which allow of egress by the window into the street. There are a great many kinds of both, so many, in fact, that it would be impossible to do justice to them all in the short space of time at my disposal. A few, however, may be described, to give an idea of their nature and value. Many of these are exhibited in the library, and can be examined after the meeting.

Some depend on a permanent iron ring

fixed in the brickwork above the window, and others are fixed on the "sill" of the window for support. One brought to my notice a short time since, consisted of an iron rod running the length of a street, where all houses were of the same elevation—on this ran a trolley to be worked to the required place by a policeman or other person in the street. Attached to the trolley were means of descent by rope and pulley. Of portable escapes, a canvas pipe arrangement by which one may enter at the top, and the end being held out in the street, slide down, stopping or breaking rapid descent by pushing against the sides, is I think the most popular and easy.

Inventors, however, have a great difficulty in producing any appliance that will be a commercial success, for the simple reason that each purchaser has to be individually convinced of the excellence of the appliance; and considering that not one per cent. of of the householders in any town would ever think of purchasing such an apparatus, it will be at once seen why failure has been so general and universal in this respect. So many lives being lost at a distance of only twenty or thirty feet from the ground has led to the suggestion of a net, such as acrobats fall into, being kept ready in a box, so that it can be stretched out by attachment to iron rings; this is possible, however, only where there are two sides to the street. Rope-ladders are of difficult descent unless held well out at the bottom. Many hotels have iron ladders fixed outside the building; when there is only one staircase this is a most necessary precaution. It was a custom to keep ordinary ladders, of good length, under a cover outside the parish church, and there can be no doubt but that in villages and many small towns ready access to an ordinary ladder would be the means of saving life in case of accident. The ladders, however, unless chained and locked, are liable to be used for the purpose of gaining access to houses by thieves. One inventor has constructed a ladder, to be attached to the side of the house and let out when required, at other times lying flush with the brickwork. This certainly possesses advantages. Another ladder, shown in public some time since, falls from a balcony from floor to floor, until the pavement is reached.

These, or similar appliances, are very necessary in public buildings, such as lunatic asylums, schools, or other places where a large number of persons are sleeping under one roof, and it is a matter for consideration whether, when life is jeopardised to so great an extent from accident by fire, it is not the duty of the Government to enforce the adoption of some means of preserving life. One point, in considering any methods of escape from a burning house, must not be missed, and that is that it must be as simple as possible; it must also be inexpensive.

In considering the question of escape from fire, too much allowance cannot be made for the terror or panic produced by the sudden knowledge of so serious and appalling a danger. Only those who have actually experienced the fact of having had their lives, as it were, in the balance, can adequately appreciate the paralysing influence a sudden knowledge of such dreadful and imminent danger has on the brain. Appliances that require any careful fixing, or are encumbered with the slightest trivial detail, are absolutely useless to people terrorized by fright. Descending from a height into the street, outside the house, by almost any unaccustomed method, is, at the best of times, nervous work for timid people, and more especially on a sudden awakening from sleep. The sensation that one's life depends on instant action causes an impulsive and spontaneous working of the brain, that in women absolutely renders them incapable of any motion whatever, although they may be perfectly well aware of the danger they are in, and even strong men are guilty of the most ridiculous actions. In one case, a man waking up and finding the room full of smoke, instead of at once alarming the other sleeping inmates, lost considerable time in looking for a candle and matches, and contributed to the loss of several lives thereby. This terror or fright caused by fire and a sudden knowledge of its danger must be kept well in mind in considering all points of the question of saving life. However much value may, therefore, be attached to appliances for self-preservation from fire, the necessity of providing qualified external assistance by men trained to such duty will always remain, and the question of providing such mechanical appliances as will effect the rapid application of such help has still an open field for human ingenuity. Every householder should define a line of action to be followed in case of fire. Those without any mechanical means of saving life should provide a piece of rope (Manilla rope is the best), of sufficient length to reach from roof to basement; a strong belt, made fast to the end, should, when used, be buckled directly under the arms and round the chest and

back of the person to be lowered; the rope can be secured by passing it once or twice round the leg of a bed, and it will then pay itself out when slackened. By this means one person can lower all others to the ground, and escape himself by making the rope permanently fast and sliding down it.

I now purpose, in the most concise way possible, giving some simple directions how to act on the occurrence of fires. Fire requires air; therefore on its appearance every effort should be made to exclude air—shut all doors and windows. By this means fire may be confined to a single room for a sufficient period to enable all the inmates to be aroused and escape; but if the doors and windows are thrown open, the fanning of the wind and the draught will instantly cause the flames to increase with extraordinary rapidity. It must never be forgotten that the most precious moments are at the commencement of a fire, and not a single second of time should be lost in tackling it. In a room, a tablecloth can be so used as to smother a large sheet of flame, and a cushion may serve to beat it out; a coat or anything similar may be used with an equally successful result. The great point is presence of mind; calmness in danger, action guided by reason and thought. In all large houses buckets of water should be placed on every landing, a little salt being put into the water. Always endeavour to attack the bed of a fire: if you cannot extinguish a fire, shut the window, and be sure to shut the door when making good your retreat. A wet silk handkerchief tied over the eyes and nose will make breathing possible in the midst of much smoke, and a blanket wetted and wrapped round the body will enable a person to pass through a sheet of flame in comparative safety. Should a lady's dress catch fire, let the wearer at once lie down, rolling may extinguish the fire, but if not, anything (woollen preferred) wrapped tightly round will effect the desired purpose. A burn becomes less painful the moment air is excluded from it. For simple burns, oil or the white of egg can be used. One part of carbolic acid to six parts of olive oil is found to be invaluable in most cases, slight or severe, and the first layer of lint should not be removed till the cure is complete, but saturated by the application of fresh outer layers from time to time.

Linen rag soaked in a mixture of equal parts of lime water and linseed oil also forms a good dressing. Common whiting is very good, applied wet and continually damped with a sponge. The St. John's Ambulance Association advise the following to restore breathing:—To clear the throat, place the patient on the floor or ground with the face downwards, fold one of the arms so that the forehead may rest upon the forearm, in which position all fluids or smoke will more readily escape by the mouth, and the tongue itself will fall forward, leaving the entrance to the windpipe free. Assist this operation by wiping and cleansing the mouth. To excite breathing turn the patient well and instantly on the side, supporting his head on his forearm and excite the nostrils with snuff, hartshorn, and smelling salts, or tickle the throat with a feather, &c., if they are at hand. Rub the chest and face warm, and dash cold water or cold and hot water alternately on them. To initiate breathing, draw the tongue out and keep it out by means of an elastic band passing over it and round the chin. Replace the patient on his face, raising and supporting his chest well on a folded coat or other article of dress. Turn the body very gently on the side, and a little beyond, and then briskly back again on to the face, repeating these measures cautiously, efficiently, and perseveringly, about 15 times to the minute, or once every 4 or 5 seconds, occasionally varying the side. On each occasion that the body is replaced on the face, make uniform but efficient pressure, with brisk movement on the back, between and below the shoulder-blades, or bones on each side, removing the pressure immediately before turning the body on the side. By placing the patient on the chest, the weight of the body forces the air out; when turned on the side this pressure is removed, and air enters the chest. During the whole of the operation, let one person attend solely to the movements of the head, and of the arm placed under it.

A word of praise must be said of the very valuable service in the cause of life-saving at fires rendered by the police. They are usually the first to discover the occurrence of fire, and frequently their efforts, attended with success, exhibit a very great amount of pluck. In many parts of this country the fire brigade is entirely composed of the police. There is no doubt that very material assistance can always be rendered by the police, and their knowledge of the use and application of machines for saving life is frequently of great value. At every fire escape station there should be two escapes, one for use at

large and the other at small buildings. Mr. Bray exhibits a very handy little machine, most easily conveyed to a fire, and when there, extending itself telescopically to a height of 35 feet. Whilst the firemen are getting the larger machine to the fire, the police might frequently render great help with the smaller one.

And last, but not least, our canine friend the dog has frequently been of great service at fires. Sam Wood, an escape conductor, who used to have charge of the Whitechapel fire-escape, had a dog that would ascend and descend ladders with the greatest ease. A case of the sagacity and usefulness of the dog occurred at Rochdale in August, 1885, the particulars of which I know to be perfectly accurate. The scene of the fire was a hosier's shop. About two o'clock in the morning the inmates were awakened by the cries of fire from the street below. A Mrs. Belmont seized the youngest girl, and groped her way through choking smoke to the stairs. In descending she became overpowered and fell, being safely got through a window which she had smashed. In the meantime, two other girls had not the courage to follow, and stood at the window. The fire-escape, through lack of men, had been left behind. The two girls afterwards dropped into a blanket held for them, one bounding out again, however, breaking several of her ribs. One of the sons, aged about 11, had meanwhile appeared at another window. The escape had now arrived, but the smoke was so dense that it was impossible for anyone to ascend it, and there sat the little lad on the window-sill for upwards of five minutes, being burned by the heat, and having no way of escape open, for he dare not take that terrible leap. Then as jets of water, which were poured into the shop, reduced the blaze, Fireman Cragg got through the window of the drawing-room (immediately above the shop), and penetrated into the kitchen. Cragg attempted to ascend the stairs, but the smoke was so dense that he was driven back. Some others soaked some clothes in water, and placed them in the holes through which the smoke was pouring, and in this way the atmosphere was cleared somewhat. Cragg then groped his way upstairs, guided by a moaning which he thought was that of a woman, into a room where he fell over the large retriever dog, which was lying in the room, and which, with his dog-like faithfulness and instinct, had been moaning to attract attention to the child in bed. This is proved by the fact that after the child was removed the dog made no further noise. Cragg felt about the bed, and found a child under the clothes in a state of partial suffocation.

The little fellow, about eight years old, had previously accompanied Mrs. Belmont to the top of the stairs where terror overcame him, and he ran back and scrambled into bed and hid himself under the clothes. Cragg ascended the stairs again for another rescue, that of the lad on the window-sill, which he effected. Cragg, nothwithstanding a bruised leg, now resolved to risk the task of saving the dog. Going up the stairs for the third time, he found the dog lying quite helpless in the bedroom. Notwithstanding its great weight he lifted the animal and carried it downstairs into the street, where it soon recovered, but the dog's eyes had been blinded for it was seen afterwards staggering about like a drunken man, bearing its suffering in the mute patient manner dumb creatures have. In 1886, when the provincial firemen took part in the Lord Mayor's Show, I placed Cragg and his dog "Carlo" in front with the men who had saved life from fire, and the dog appeared quite conscious of the honour paid him by the British public.

In conclusion, I have again to most sincerely thank Mr. Cook for his great kindness in allowing me the perusal of the records of the Royal Society for the Prevention of Life from Fire, as also many prominent firemen who have assisted me with their valuable advice, amongst whom I must specially note Fire-Master Wilkins, of Edinburgh, and Superintendent Reilly, of the Belfast Fire Brigade.

A collection of apparatus, in illustration of the subject of the paper, was exhibited in the Reading Room, by the following makers and inventors :—

Bailey, H. T.—Patent domestic fire-escape.

Beck and Co.—Fire-plugs and valves; patent hose coupling.

Brazier, T.—Patent fire-escape.

Clowes, I.—Model for portable domestic fire-escape.

Cluse, W.—Model for patent fire-escape.

Edgington, J. C.—Rope fire-escape ladder.

Hayward, Tyler, and Co.—Hand fire-engine; steam pump and hydrant.

Heath, I.—Patent fire extinguisher; folding balcony.

Heathman, J. H. and Co.—Window fire-escapes, hand pumps, ladders, &c.

Piggott Bros.—Domestic fire-escape.

Sinclair, J.—Dick's extincteurs; patent smoke respirators; Harden star hand grenades.

Spong and Co.—Pneumatic fire air extincteur; tube hand grenades.

Wethered, Colonel.—Appliances for rescuing persons from window of adjoining house.

DISCUSSION.

Colonel WETHERED said he spoke at some disadvantage, being the inventor of a domestic fire-escape. There could be no doubt that the street fire-escape was exceedingly valuable, and nothing but praise could be given to those who had the control of it; but many lives were still lost, and the question was whether there were not defects in the present system which might be remedied. A fire generally occurred in the basement of a dwelling-house, after the inmates had gone to bed, and it might smoulder for a long time while all doors and windows remained closed, but as soon as these were opened the flames burst out and made rapid progress. One evil of the street fire-escape was that people trusted to it and adopted no other means, and they all rushed to the front windows, sometimes after opening those at the back, and thus a great rush of air was set up, which intensified the mischief. Some means should be devised for rescuing people from any window they might be at, back or front. There were several means for doing this, but the point he wished to insist upon was that the window of an adjoining house was the nearest point of approach, and could be readily utilised. He had frequently visited the scene of fires in London where life had been lost, and never saw a case where the person could not have been reached from the adjoining window if only he knew what to do. Communication could be made by passing a rope round the two sashes, forming a loop, and passing a rope through that to the next house, where a person could easily lower another from the burning house, the friction of one rope on the other loop being quite sufficient to bear the weight. Of course a mechanical appliance would be better, and that was the nature of his invention. If a strong hook were placed between each pair of windows, back and front, a small appliance with a pointed rod, which might be used by a policeman, could easily be hung on to it. The police should have the means of rescuing persons from fire, and they could do so if each man had on his beat, in a proper receptacle, a proper appliance which he could hang on to the hook provided, by getting into the adjoining house. His invention consisted of a simple brake, which acted automatically the moment the weight came on the rope, and lowered it gently. No doubt persons lost their presence of mind in a fire; but this would be in great measure prevented if they knew they had the means of safety. He often went from one window to another, and had gone from the high windows in Queen Anne's-mansions to the ground more easily than he could descend the stairs.

Mr. BLAND SINCLAIR said he had had more than twenty years experience in trying to educate the public in the rapid extinction of fires, in order to save both life and property, and it was very extraordinary that, even after some severe calamity—such as the burning of the asylum at Southall some years ago—after a few weeks the feeling of dread seemed to have passed away, and had it not been for the action of the Government many asylums would not now possess any means of escape from fire. It was very necessary that the saving of life from fire, and the extinguishing of fires, should be taught in the elementary schools. On one occasion he showed some experiments to a large public school, and instructed the boys what to do in case of outbreak of fire; how, by means of a wet blanket thrown over the head, a person could pass through smoke and flame without much injury, and so on. He felt sure that the making of domestic fire-escapes had never yet been profitable for the same reason, that it was difficult to raise any public interest, and to get people to furnish themselves with the appliances, of which there were many now made at a reasonable cost.

Captain HEATH thought the great difficulty was the want of unanimity in the residents of large towns, which prevented the adopting of any universal system. To be prepared for fire you must be always ready. He, like the first speaker, was an inventor, and had a model downstairs showing a falling balcony, from under the window sill. It was rather a difficult feat to get out of a window on to a ladder for anyone unaccustomed to it, but it would be much easier to get on to a little platform underneath, and then on to a ladder or fire-escape. It would also be easy by this means to get from one window to another if the owners of the adjoining houses would consent to have a rope from one platform to the other, and a person might easily leap on to the balcony of the next house. The great want was a communication between houses on fire and those which were not. A very frequent cause of fires was the leaving a large fire burning when people went to bed. They put out candles and gas, and why should they not turn out the fire? He had a little apparatus which produced a spray holding a salt in solution, which would extinguish all flame, the large pieces of coal could be taken off and thus all danger would be removed. The reason people rushed to the front of a house was that there was more chance of help there as fire-escapes could not often approach the back.

The CHAIRMAN said he regretted being obliged to leave, having another engagement, but before going he wished to express his thanks to Mr. Shean for his paper. He had often been struck with the

danger referred to by Captain Heath, of leaving a large fire burning when you went to bed, and he would take the hint he had given. Great progress had been made during the last twenty-five years in apparatus for saving life from fire, and he desired to join those who had expressed their admiration for the conduct of firemen and the police. The firemen had to face as great dangers as a soldier, and often performed quite as heroic deeds, sometimes at the cost of their lives.

Mr. H. TRUEMAN WOOD here took the chair.

Mr. H. HARGREAVES could hardly agree that it was a safe and easy operation to pass a person from one window to another. In considering the subject generally, he had been struck with the fact that nearly all the fatal accidents took place either in houses occupied by a large number of people, such as tenement houses, or in large mansions. In the latter case, the accident generally arose from the fact that there were too few people to look about and see that everything was safe, and in the former from overcrowding, carelessness, bad lamps, and so on. The paper was very valuable, but it struck him as being rather too historical, and not offering much in the way of suggestion. The great difficulty, as had been said, was the indifference of the public. At the Inventions Exhibition, having shown his apparatus to the visitors, they had more than once said it was a first class thing, and that Government ought to compel everyone to use it. He would then say he quite agreed with that, but in their own case there was no need of an Act of Parliament; they could have one themselves, and so set a good example, but they never seemed to see the matter in that light. Inventors might go on piping, but the public would not dance. How was this difficulty to be got over? They looked to Government now-a-days to do a good deal, but he doubted if an Act would ever be passed to compel people to adopt fire-escapes, and if it were, the question would arise, which escape should be chosen. He could not conceive anything more useful than to train the rising generation how to act in such cases of emergency. He could only hope, as the result of the able papers which had been read in that room from time to time, that some simple and effective means of saving life from fire, either from the street or from inside the house, might be devised. They all rejoiced in the efficiency of the Metropolitan Fire Brigade, but the firemen had to fight against time, and however perfect the apparatus, if it could not be got to the scene of danger in time, it was of little use. Most of the accidents happened in the first few minutes, and therefore it was not safe to rely merely on outside help, means of escape should be provided inside. He agreed with Mr. Shean that means should be provided for escape by the roof, and thought that some structural appliance in that direction would be the solution of the problem.

Mr. COOK (Secretary to the Royal Society for the Protection of Life from Fire) said there was no doubt that very valuable service was rendered by the police, by far the larger number of applications for rewards coming from that body, and they were generally found on investigation to be well founded. Some fifteen years ago a committee was appointed by the House of Commons to inquire into the general protection of London from fire. Some of the most influential people gave evidence, and there was an exhaustive report by the committee, of which Sir H. Selwin Ibbetson was chairman, the strongest recommendation of all being that the duty should be handed over to the police, and that the Fire Brigade should be amalgamated with it. When the old fire offices handed over their plant to the Government, the intention was originally that it should be placed in the hands of the police, and an offer was made to the Home-office, but they did not seem to care about undertaking the duty, or the police either, and so it was handed over to the then new body, the Metropolitan Board of Words. He should have been glad if Mr. Shean could have given more information what to do in cases of burning, for many persons died from ill-treatment after they were burned. He knew of a case not long ago where a life was lost entirely through an enthusiastic person tearing off the burning clothes, which should have been left on.

Mr. W. LASCELLES-SCOTT asked if Mr. Shean could say anything as to the practical value of asbestos fabric in connection with fire-escapes. They had heard something of the comparative merits of wire gauze of different metals, but it must be remembered that wire gauze unless protected would be useless in anything like a wind. Even a Davy lamp which was so effectual in a still atmosphere was a source of danger in a draught; but if the wire gauze were coated with something absolutely indestructible like amianthus or asbestos cloth, it might be of great service, the one material giving the requisite strength and the other preventing the effect of heat. There were a large number of meritorious appliances which only wanted to be adopted to prevent the possibility of anyone being burned, but the question was to make people adopt them, and to educate them in their use at the critical moment. The education of our boys and girls was the great thing, and he was glad to know that something at least was being done in this direction; in some schools the boys were put through fire drill, but he thought it would be well if some recommendation went from the Society that this plan should be generally adopted; and if a set of instructions were issued, pointing out what might be done with the ordinary appliances to be found in all bedrooms. Having tried a few experiments, he did not think there would be any difficulty in getting out of any bedroom window in from four to eight minutes, with the aid of sheets and blankets, and a few rungs knocked out of a chair. Reference had been made

to the hand grenades, which were supposed to be effectual in extinguishing fires, some of which were so, and others were not; but every one might remember that a bottle or two of soda water, or a syphon charged with carbonic acid gas, would put out a comparatively large fire. A few drops of chloroform were also very effectual, and if to these two ingredients were added a little ammonia, in the form of smelling salts, you had one of the most powerful agents for extinguishing a fire in its early stages which could be imagined.

Mr. J. H. HEATHMAN thought this question should be pressed upon property owners and large employers, who were often utterly indifferent to its importance. He had gone over many places where the lives of the operatives would be in danger if a fire broke out in the daytime when the fire-escapes were off duty, and on calling the employer's attention to it, they showed no concern whatever. On one occasion he visited a large factory of seven stories, with only one staircase, and on every floor there were long tables crowded with girls and lads, and there was no means whatever of escape in case of fire; he suggested that an exit should be made in the roof, and a ladder provided; but although that was three years ago, he knew it had not been carried out. He thought this matter ought to be looked after by factory inspectors quite as much as sanitary conditions. Having described the mode in which a jumping-sheet should be held, he said he had tried some experiments with asbestos, but its weight was prohibitive, and the fibre was too short to afford sufficient strength. A canvas shoot was good in some situations, but in an exposed position he should condemn it, because it caught the wind, and he would recommend a rope escape in preference.

The CHAIRMAN, in proposing a vote of thanks to Mr. Shean, said several papers had been read before the Society dealing with various aspects of this subject. Mr. Braidwood read a very valuable paper, which attracted a good deal of attention, in 1856, and since then there had been several others, but there had never been one dealing entirely with the important question of the rescue of persons from burning buildings. The conclusions of the Parliamentary Committee, of which Sir H. Selwin-Ibbetson was chairman, were, to a large extent, based on information supplied by a committee of the Society, of which Mr. Edwin Chadwick was the chairman, which sat for several years, and collected a good deal of useful information. He might also mention a report on the subject of preventing fires in theatres, published in the *Journal*, in May, 1883, the appendix to which contained a summary of the work done with regard to rendering fabrics uninflammable. As long ago as the middle of the last century people were devising cranes and other things for rescuing persons from fire, and in 1788 a patent was taken out for something which looked very much like a modern fire-escape. From that time onwards there had been many inventions of this kind. He should like to know if Mr. Shean could say whether any of the domestic appliances had been actually serviceable in saving life.

The vote of thanks having been carried unanimously,

Mr. SHEAN, in reply, said he believed that on one or two occasions life had been saved by domestic fire-escapes, but beyond that he could not go from his own knowledge. With regard to Mr. Cook's remark as to the service of the police at fires, he might say that whenever an escape was moved the police rendered great assistahce, and it was to be regretted that, even if the police and Fire Brigade were not incorporated, the former should not receive some little training, because with the present cumbrous escapes, a little knowledge on the part of the police would often be of the greatest service. Even if the shoot were made of incombustible material, the woodwork would be exposed occasionally to the flames; wire netting would be heavy, and would be likely to cause injury to a person sliding down it. When a fireman had to rescue a person at a high window he had to carry him down to the main ladder, where the shoot began, in any event, and he generally brought him all the way to the bottom, and he was therefore in favour of doing away with the shoot altogether, and letting people either come down the ladder, or be brought down. Mr. Heathman was probably right about the jumping-sheet, but there was seldom sufficient strength available to render this at all a safe means of escape, and practically he considered it almost useless. The only reference he intended to make to Government interference was that all large buildings ought to be compelled to have some means of escape, just as ships were compelled to carry a certain complement of boats.

Mr. HEATHMAN asked leave to reply to the question put by the Chairman as to the use of domestic appliances. There was recently a fire at a large hotel in Philadelphia where twenty-seven persons were saved by fire-escapes which were kept on the premises.

Miscellaneous.

CULTIVATION OF CAOUTCHOUC-YIELDING PLANTS.

By THOMAS T. P. BRUCE WARREN.

Looking at the increasing commercial importance of india-rubber, and the few fresh sources of supply which have been added to augment our stock of this

substance, we are forced to admit that the activity of our experts have not been marked with that success which a manufacturer can wish for.

Caoutchouc is much more widely diffused in the vegetable kingdom than many are aware of. An idea exists that any plant which yields a lactescent juice contains caoutchouc. There is an error in such a proposition being too generally accepted, because of the disappointment which follows an unfavourable report; still, it would be very unwise to assume that any plant yielding a lactescent juice is unworthy of a careful examination for caoutchouc.

There seems to me a great want of a reliable method for examining the juices of plants for caoutchouc. It cannot be too forcibly impressed upon those who are interested in this matter, that the recently-drawn sap of a plant should be examined, if possible; even experienced people consider that caoutchouc is too permanent in its character to alter. When caoutchouc is isolated from resins, oils, and similar principles, it may be kept for a long time, but it would be quite another matter if these were left together for some time.

The elaboration of certain principles, or secretions, by *living* plants, points conclusively to an idiosyncrasy in plant life which we ought not to ignore. We know that vitality interferes with chemical affinity, by preventing changes due to mere chemical action.

A few years ago my attention was directed to the curious changes which took place in the medicinal activity of certain plants under cultivation, as compared with the same plant growing as it were on its own natural soil. Chemical analysis of the soil and plant revealed the fact that nitrogenous matter was wanting. The mineral ash of a plant gives a fair idea of what is required in the soil so as to be favourable for its growth, but we must look to the sap of the living plant to know how far climate and other meteorological surroundings are suitable for a healthy and vigorous growth. An abnormal development of any part of a plant must be avoided if we wish to maintain its original integrity.

Warm climates are more favourable to the production of milky juices than cold climates. From this we may conclude that, in order to arrest rapid evaporation from the plant, which would of course involve exhaustion, certain principles are developed whose function is by its emulsive action to retain the water, or to impede its evaporation, we must not overlook the fact that excessive evaporation, *per se*, is injurious to a plant, but the cooling action due to rapid evaporation, has the same influence as transferring a plant to a cooler region.

In such cases, currents of dry air are productive of much mischief; moist air has little or no effect on evaporation. When the cultivation of india-rubber plants was first mooted, the idea was to work on the plant yielding Para-rubber, and considering the state of our knowledge at that time, the error of judgment was pardonable, still it is by no means improbable that the effort to raise the Para-rubber yielding plant may be again attempted.

I have often been struck with Faraday's analysis of india-rubber juice, which was, I believe, of Indian origin. The omission of ammonia, if present, could not have been passed over by such a careful observer. More recently, in examining india-rubber juices, I find that ammonia is by no means a constant ingredient in these juices.

When a juice has been coagulated, the caoutchouc which separates out cannot be redissolved, but if ammonia be added previously, the caoutchouc remains blended in an emulsive form. If the juices become acid in any way, the caoutchouc separates out.

The only juice I have examined which contains a large quantity of free ammonia is that obtained from the *Syphonia elastica*, grown in Para, and it would be extremely interesting to know whether, when the plant is raised elsewhere, this ammonia is present.

The juice of the Masaranduba (Cow-tree), although as rich in caoutchouc as the *Syphonia elastica*, and quite as good as regards quality, is not only free from ammonia, but remained for some months quite fluid. This juice was also gathered at Para.

A point of singular importance connected with the cultivation of the *Syphonia elastica*, is the fact of its juice being so rich in a nitrogen compound, when we know that the soil itself is neither manured nor supplied with nitrogen in any form, so far as we can tell. We are driven to the conclusion that the atmosphere contributes nitrogen to the plant.

This brings us to the consideration of the meteorological conditions under which the Para india-rubber plant grows, and will help us to explain why it is that this plant will not grow productive of caoutchouc, even when transplanted to the same parallel of latitude.

During the evening, and greater part of the night, it is curious to note the vivid lightning which plays almost incessantly among the trees along the Para river; there is a decided absence of that violence which characterises a thunderstorm; in fact, if rain sets in, it is almost invisible. Do these silent electric discharges in warm, damp air, assist in generating ammonia?

If it is impossible to transplant the *Syphonia elastica* to a suitable climate, with the meteorological accompaniment as found at Para, we are certainly justified in trying an experiment by supplying it with ammonia in some form, so that under the influence of vegetation, it may approach the assimilative action of what nature supplies to the Para plant.

I am convinced that in some parts of our colonies, we may reasonably expect that rubber cultivation can be successfully carried out.

The Mangabeira (Mango-tree) and Masaranduba (Cow-tree), are worth experimenting on, as their cultivation do not require anything particularly special but what an ordinary grower can supply, of course a suitable climate being granted.

Analyses and general descriptions of the soils on

which caoutchouc producing plants are grown, are indispensable, as from them any soil to which a plant may be transferred for cultivation, can be selected or made up so as to represent the natural soil on which it previously grew. This assistance would help to relieve an intending cultivator from the onus of delay in fruitless experimental trials and expense.

This would be a very simple matter, as our foreign Consuls would have no difficulty in procuring authentic samples of the soil and of the wood of the rubber plant raised on it.

FISH CULTURE IN SWITZERLAND.

Consul Catlin, of Zurich, says that Switzerland, with her many lakes, her deep water courses, and her innumerable mountain brooks, possesses unsurpassed attractions for the lover of pisciculture, and that these advantages are appreciated by the Swiss themselves is evidenced by the stringency of the laws pertaining to fishery rights in every canton, and also especially of late years by the endeavours, both by legislation and by private enterprise, to protect the fish and develop artificial breeding. In the feudal times the fishery rights appear to have belonged almost exclusively to the monasteries, and under that régime but little attention was given to developing or protecting fishery. The oldest record on this subject appears to date back to the year 1291, and mentions a certain right to fish at the Castle of Wörth, at the Falls of the Rhine. In 1308, the Abbot of the All Saints' Monastery, at Schaffhausen, made over to one Conrad Gelser the right to fish in the Rhine from Busingen to Kloster-Mühlan ; in 1316, Duke Leopold of Austria transferred the lake fishing at Zug and Aegri to Ritter Heinrich von Stein for thirty silver marks, and in 1390, Adelheid von Hüneberg sold her rights "on the Lorzen, below Kestmer's mill, and as far as the lake," for "thirty pounds of Zurich pennies." As early as 1384 the city of Berne claimed the fishery rights on the lake of Thun, and from 1411 only members of the Fishermen's Guild could engage in fishing at Schaffhausen. In the year 1554, the Zurich Council took control of the fishing on the Glatt, and decreed that millers on that stream "must construct sluices to their dams, and furthermore, leave the same open, and not fish beyond their dams." During the 15th and 16th centuries there were frequent quarrels over fishery rights, and the monasteries were often involved in them, but they were always settled by appeals to courts or councils. In 1784, after a demand from the city of Berne that all fish taken in the lake of Thun should be brought thither for sale, it was decreed that Berne should have two-thirds, and Thun one-third, of every catch, with a proviso that two per cent. be always reserved for the *amtmann*, or supervisor. The oldest fishery laws date from 1386 for Schaffhausen and Zurich, from 1402 for Basle, and from 1458 for Berne. At the present time each canton has exclusive control over its own fishery rights, and the Federal law governing the whole is very simple and complete. The aggregate extent of water on lakes, rivers, and brooks available for fishing purposes in Switzerland amounts to 34,036 kilomètres, or about 21,150 miles, belonging partly to townships or to private owners. Great efforts have been made during the past ten years in Switzerland to advance the artificial culture of fish. In the year 1885, the Federal Government distributed the sum of 6,790 francs in prizes to fish breeders, and the amount thus disbursed since 1880 is 31,806 francs. Weekly lectures of two hours' duration are given on the subject of pisciculture in the Agricultural and Forestry Department of the Federal Polytechnic School in Zurich. Occasionally notices appear in the local papers stating that a consignment of young fish from America or Germany has been received. The eggs for breeding purposes are mostly imported from the United States or from North Germany, and consists principally of what are known as American white fish, American brook salmon, land locked salmon, and American rainbow trout. During the year 1885, 5,709,432 fish were hatched at the various breeding establishments. Consul Catlin says that the enemies of the fish abound in Switzerland, and chief among them are the fish otter, fox, polecat, herons, cormorants, gulls, eagles, kite, ducks, geese, shrews and water rats, and against these the friends of fish have declared relentless warfare. The depredations of the fish otter in particular are so destructive and wide-spread that the Diana Hunting Association, an organisation existing throughout Switzerland, with head quarters at Berne, has a contract with a firm at Oarburg for supplying packs of trained otter dogs, on the demand of fishery owners in any part of the country. Another cause retarding the development of the natural growth of fish, is found in the fluctuations in the depth of water in brooks and rivers, caused in many cases by the diversion of the supply into factory races. To obviate this, the Federal Council is empowered to bear one-third of the expense of providing, in any running water, permanent free channels for the passage of fish. Under this provision five channels have been constructed, viz., in the Saane, at Freiburg ; in the Birs, near Basle ; in the Reuss, at Lucerne ; in the Lorz, at Cham ; and in the Limmat, at Baden. Among other causes which operate prejudicially to the natural increase of the fish supply, and which Swiss legislation is endeavouring to prevent or remove, are the destruction of reeds and water plants, changes in the shore front of brooks and rivers, destruction of the bushes along the same, and the dissimilar treatment of the migratory fish in different localities. The Swiss Government has done much to bring the question of fish protection into a proper form. Treaties exist

with Baden, Alsace Lorraine, France, and Italy, for the proper protection of the frontier waters. In addition to this, a system of twelve reserve districts, in which fishing may be prohibited for a fixed period, has been organised. These districts cover a total area of 4,753 square miles, and are principally located in the cantons of Berne, Graubünden, and Zug, with small reserves also in Glarus and Zurich. The largest of these, with an area of 1,500 square miles, includes all the waters of the Engadine from Tarasp to the point where the River Inn emerges from the Silser See. The Swiss fishing industry furnishes employment to over 970 persons, and statistics show that the total value of fish caught in Switzerland, during the year 1885, amounted in value to 709,000 francs.

MOTHER-OF-PEARL FISHERIES IN THE RED SEA.

Consul Jago, of Jeddah, says that the mother-of-pearl fisheries extend the whole length of the Red Sea, from El Wedj on the North, to Aden on the South. The principal grounds are in the neighbourhood of Suakim, Massowah, and the Farsan Islands. About 300 boats are employed, the majority belonging to the Zobeid Bedouins, a tribe of Arabs inhabiting the coast line between Jeddah and Yambo. About fifty boats belong to Jeddah, and two or three to Confida, Cameran, and Loheiha. They are open, undecked boats of between eight and twenty tons burden, carrying a large lateen sail, manned by crews varying between five and twelve men, and each provided with a number of small canoes, which are imported specially from the coast of Malabar. There are two fishing seasons during the year, one of four months and one of eight months, during nearly the whole of which the boats keep the sea, the crews living on board, returning to their homes for short periods of two to four weeks. The crews, composed principally of black slaves, are paid by share of the produce of their fishing, the owner of the boat taking one-third, the remaining two-thirds being divided among the former, after deducting the cost of food consumed by them during the voyage, and which consists of dhourra, rice, and fish, with sometimes a little ghee and dates as a luxury. Fatal accidents are said to be unknown, and the men are remarkable for their strength and good health. They dive between the ages of ten and forty, and the practice is said to have no ill effects. The fishing takes place in the neighbourhood of reefs, the boat anchoring at a certain spot, whence the crew proceed to fish in their canoes, in the vicinity. Operations are conducted only in calm weather, when the shell can be discovered by the eye at a depth varying between seven and fifteen fathoms. Of late years, to assist the eye, empty petroleum tins, with the ends knocked out, and a sheet of glass inserted in one end, have been used. The tin, with the glass end below, is submerged a little in the sea, and the discovery of the shell thereby facilitated. During the last ten years the find is said to have diminished ten to twenty per cent. in quantity, owing to dearth of shells. The value of the total harvest is estimated at 120,000 to 170,000 dollars annually, the dollar varying in value between 3s. and 3s. 6d. The short season of four months, which used to average between 40,000 and 50,000 dollars, only realised in 1886, 25,000 dollars. Formerly, all the produce of the Red Sea was brought to Jeddah for sale and export, but recently, owing to fiscal and custom-house restrictions, only about one-fourth now goes there, the remainder going to Suakim and Massowah. Shells imported at Jeddah for sale are disposed of by public auction in heaps of about half a hundredweight each. As preliminary inspection is not allowed, the bidding is purely speculative, and bidders have to take account of dirt, coral excrescences, and inferior shells. Prior to exportation the shells are sometimes cleaned to remove the coral and dirt, and are then packed in barrels. Up to ten years ago all shells brought to Jeddah for sale were shipped by natives to Cairo to be sold there. Now, however, the bulk goes to Trieste, a small quantity to London, and a little to Havre; and a few of the finest and largest shells are purchased for exportation to Bethlehem, where they are engraved and sold to pilgrims. The Jeddah shell is considered in Europe inferior to that exported from Suakim and Massowah, owing, it is said in many instances, to the yellowish tint of the former, and the fact that many of the shells have a greenish tint round the edges. Some ascribe this to the excessive dampness of the climate of Jeddah. With regard to the origin of the shells, the following distinctions are made :—*Dah al ak-i* shells, found on the group of islands of this name, situated along the African side of the Red Sea; *Barr-adjem-i* shells, found along the same coast, north of the Khôr or inlet of Suakim; *Farsan* or *Yeman-i* shells, brought from the Farsan group of islands, on the Arabian side of the Red Sea; *Shebak-i* shells, from the banks between Confidah and Leet; *Sham-i* shells, from El Wedj down to Hassanee Island on the Arabian side, and found in the neighbourhood of Kossaïr on the African side. Consul Jago says, in conclusion, that the *Sham-i* is the best, and the *Yeman-i* the most inferior quality.

orrespondence.

STATISTICS IN CILICIA, TURKEY.

While depression of trade is still keenly felt in England, it may be of some use to the commercial community at large to get an outline of the various native products and articles imported into, and

exported from the Vilayet of Adana (Cilicia), the more so as a large amount of English capital is already invested in the Mersina, Tarsus, and Adana Railway, recently constructed by an English company. But before proceeding with my dry numbers I think it will be useful to give a short sketch of the position of this rich province, which develops on the south a length of sea shore of 330 miles, and a total area of about 16,000 square miles. The plain Adana is of ancient renown as an excellent fertile soil; it is almost 66 miles long, by an average of 15 broad. Besides a number of small streams, the Cydnus, Pyramus, and Sarus traverses the plain; cotton, sesamy, wheat, barley, and raisins are its principal products. Adana, the residence of the governor-general, is a flourishing town of 60 to 70 thousand inhabitants. There are seven steam cotton ginning factories, working 158 gins, while there are about 2,000 native hand-gins at work. The average produce of cotton in this district is 35,000 bales of three quintals each. Tarsus is next in importance; there are between ten and fifteen thousand inhabitants, and it possesses six steam cotton ginning factories, with 130 gins, and about 1,000 native hand-gins; its produce of cotton is about 1,000 bales. Not counting the immense quantities of wheat, barley, &c., the plain produces two other valuable articles of export, of which the principal is 5,000,000 okes of sesamy, and about 70,000 quintals of dry raisins. On the north, the Taurus mountain chain, appertaining to the province, possesses 392,065 hectares of various large forest trees; besides, there are rich mineral deposits of silver, lead, iron, lignite, &c. There are 700 kilometres of carriage road nearly finished. The population of this extensive province is, according to official data, 354,200 souls. It will be seen at a glance what is wanted to quintuple its productive capacity; and in consequence of this scarcity of population a farm of 2,000 acres can be bought for 1,400 liras. The area of land now under cultivation is 2,154,636 hectares. I now come to the principal port of this vilayet, which is Mersina, a town situated almost opposite to Cyprus, as yet, comparatively speaking, little use made of. The official shipping list for the year 1886 is given in Table I.

TABLE I.—*Navigation of the Port of Mersina for the year* 1886.

Nationality.	No. of Steamers.	Tonnage.	Sailing Ships.	Tonnage.	Observations.
French	73	103,572	...	...	54 regular and 19 extraordinary steamers.
English	89	47,996	...	..	79 coasting and 10 ,, ,,
Austro-Hungarian	2	1,565	...	...	Extraordinary.
Italian	1	665	3	730	,,
Greek	14	2,731	17	3,369	,,
Turkish and Egyptian ...	84	104,561	100	3,500	46 regular Egyptian steamers.
Russian	58	78,143	...	...	All regular steamers.
	321	339,233	120	7,599	

N.B.—This list contains merely the shipping which entered Mersina. Besides the small coasting trade, all under Turkish flag does not figure in this list, therefore, between large and small sailing vessels, there are 530 crafts, with a tonnage of 19,622, which must be added to the above total.

I have to thank Mr. Daras, Austro-Hungarian Vice-Consul at Mersina, for the data upon which the Tables are founded. Half the imports and exports of the returns may be assigned to the Trans-Cilician provinces and the other half to the Vilayet of Adana.

Although Adana is an important province in itself, yet the Trans-Cilician provinces of Caramania, Konia and Césarea (Cappadocia and Lycaonia) might become again the granaries of Europe if only railway communication could be opened to the nearest sea port; at present only a small proportion of the produce comes by camel, horse and mule. According to the best sources of information, during eight months in the year (in the summer months the people are occupied with husbandry), a daily average of 300 camels and 50 horses or mules arrive at Mersina from these provinces, bringing mostly wheat, some wool, skins and hides, preserved meat *pasturma*, yellow berries, gums, &c. In fine weather these animals travel ten and twelve days through the Cilician gates, and their average hire to Mersina is 15s. or nearly two-thirds of the value at Mersina of the merchandise carried, while for any load back they get about 8s. Notwithstanding the small quantity of produce which can be transported by such pre-

TABLE II.—*Return of the Principal Articles Imported into Mersina in the year* 1886.

Articles imported.	Tonnage.	Value in £	Observations.
Colonial, *i.e.*, coffee and spices	254	11,000	France and Austria.
Sugar	1,555	39,000	" "
Rice	524	9,400	From England and Italy.
Drugs	135	1,000	Various countries.
Iron, steel, and other articles	1,576	28,000	England and Trieste
Fruits	154	3,000	Various countries.
Manufactured goods, cotton, and wool	2,213	354,000	" "
Leather	545	61,000	" "
Petroleum	650	8,000	America & Russia.
Matches	56	3,300	Trieste.
Food stuffs	369	16,000	From various countries.
Hardwares	51	5,000	" "
Soap	187	5,900	Syria, Candia, &c.
Tobacco	145	51,900	Turkish provinces.
Wines, liqueurs, and alcohol	73	3,600	Different countries.
Other articles	708	40,000	" "
	9,195	763,000	

TABLE III.—*Return of the Principal Articles Exported from Mersina in the year* 1886.

Articles exported.	Tonnage.	Value in £.	Observations.
Wheat and barley	16,854	110,000	To France and Italy.
Oil seeds, sesame	8,200	123,000	" "
Cotton	2,400	96,000	France and Austria.
Wool	1,183	47,000	" "
Cotton seeds	1,900	5,000	England.
Wax	27	3,700	France and Italy.
Yellow berries	276	19,800	Various countries.
Gums	154	31,000	" "
Fruits	110	2,600	France.
Other cereals	652	7,200	Various countries.
Opium	1½	3,100	" "
Hides and skins	467	28,000	" "
Food stuffs	177	7,400	" "
Dry raisins	2,900	5,400	France and Austria.
Carpets	32	5,000	Various countries.
Timber and planks	1,180	26,000	Egypt.
Other articles	339	27,000	Various countries.
	36,842½	595,000	

carious means and from such remote districts, yet it will be seen by a simple multiplication that 85,400 beasts of burden come into Mersina annually, and in hire alone they absorb about £85,400. Supposing the present line of railroad, Mersina, Tarsus and Adana, is extended beyond the Taurus range (the difficulties are not such as are generally believed, for a carriage road has actually been

TABLE IV.—*Showing the proportions of the values of articles imported from and exported to the several countries aforesaid, for the year* 1886:—

	Imports. £		Exports. £
America (United States)	2,400	....	—
Austria-Hungary	24,000	....	32,000
France	160,000	....	280,000
Germany	32,000	....	—
Greece	24,000	....	8,000
Italy	12,000	....	70,000
England	160,000	....	28,000
Turkey	240,000	....	80,000
Egypt	—	....	80,000
Russia	—	....	6,000
Other countries	9,000	....	11,000
	£660,000		£575,000

constructed through the Cilician gates) without exaggeration at least six times that quantity of stuff might be brought down at once, and this would quickly increase, as the population would soon appreciate the facility of transport. A railway from Constantinople to Bagdad would be a subsidiary feeder to the line I indicate. It stands to reason that cereals and other similar articles of export will not be carried as far as Constantinople, when the distance to the seaside can be shortened by half the space. This argument applies equally to the shipping. What corroborates my idea is, that the population of those provinces, though composed of a dozen various races, is the most peaceable and law-abiding in Turkey; no robberies nor brigandage is heard of. This favourable and laborious disposition of the population is an excellent security for any capital invested now or hereafter. That the country is apt quickly to develop can be seen from the energy displayed along the railway, by the number of buildings now in process of erection at Mersina, Tarsus, and Adana.

In conclusion, Asia Minor is yet a *terra incognita* to the industry and commerce of the outer world. I will only add one more word, and that is, *Sic itur ad præmium.*

S. STAB,
Corresponding Member Society of Arts.
Consul-General for Liberia.

Smyrna, 15th March, 1887.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MAY 4.—"Agricultural Education." By J. C. MORTON. The Right Hon. SIR THOMAS DYKE ACLAND, Bart., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

APRIL 29.—"Village Communities in India." By J. F. HEWITT. HYDE CLARKE will preside.

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

MAY 10.—"The Architecture of London Streets." By E. J. TARVER, F.S.A. E. C. ROBINS, F.S.A., will preside.

Cantor Lectures.

The Fifth and Concluding Course will be on "The Chemistry of Substances taking part in Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

LECTURE I.—MAY 2.—General division of the subject.—Description of terms.—Condition affecting fermentation and putrefaction.—General description of the more common forms of fermentation—*e.g.*, alcoholic, lactic, acetic, butyric, and ammoniacal.

LECTURE II.—MAY 9.—Resolution of complex into simpler substance during fermentation and putrefaction.—Classification of common substances produced during putrefaction.—Special characters of the proximate and ultimate products.

LECTURE III.—MAY 16.—Methods of retarding and preventing putrefaction.—Physical conditions least favourable to putrefaction.—General classification of chemical methods adopted for the prevention of putrefaction.

LECTURE IV.—MAY 23.—Special consideration of the chemical substances employed.—Antiseptics.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. M. Thomson, "The Chemistry of Substances taking part in Putrefaction and Antisepsis." (Lecture I.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. S. B. L. Druce, "County Government."

Royal Institution, Albemarle-street, W., 1½ p m Annual Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. T. B. Lightfoot, "Refrigerating Machinery on Board Ship."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. P. F. Frankland, "Recent Bacteriological Research in connection with Water Supply." 2. Dr. C. R. A. Wright, "The Action of Zinc Chloride on Castor Oil." 3. Messrs. Cross and Bevan, "Pictet's Wood Pulp System." 4. Mr. John Ruffle, "The Estimation of Moisture in Superphosphates and similar Fertilisers."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m., Professor Hull, "The Rock-hewn Capital of Idumæa."

TUESDAY, MAY 3...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. E. Ayrton, "Electricity." (Lecture III.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on papers by Messrs. Grover, Fox, Stooke, and Matthews, "Water-Supply from Wells," in the London Basin, at Bushey (Herts), in Leicestershire, and at Southampton.

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Mr. C. E. Cassall, "Scavenging, Disposal of Refuse, Sewage, &c."

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 11, Hanover-square, W., 8½ p m. 1. Mr. G. A. Boulenger, "A new Snake of the genus *Lamprophis*, now living in the Society's Gardens." 2. Mr. J. H. Leech, "The Lepidoptera of Japan and Corea." 3. Mr. R. Bowdler Sharpe, "A Second Collection of Birds formed by Mr. L. Wray in the Mountains of Perak, Malay Peninsula."

WEDNESDAY, MAY 4 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. C. Morton, "Agricultural Education."

United Service Inst., Whitehall-yard, S.W., 3 p.m. Major J. D. Douglas, "Studies on Transport during Operations in South Afghanistan in 1881-2."

Entomological, 11, Chandos-street, W., 7 p m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

THURSDAY, MAY 5...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. N. E. Brown, "*Vaccinium intermedium*, a new British Plant." 2. Mr. C. B. Plowright, "British Heteraecious Uredines."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. R. Warington, "A Contribution to the Study of Well Waters." 2. Mr. A. Wynter Blyth, "The Distribution of Lead in the Brains of Two Lead Factory Operatives Dying Suddenly." 3. Messrs. J. E. Stead and C. H. Ridsdale, "Crystals in Basic Converter Slag."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture III.)

Archæological Institution, 16, Burlington-street, W., 4 p.m.

FRIDAY, MAY 6...United Service Inst., Whitehall-yard, S.W., 3 p.m. Col. Sir Charles Nugent, "The Advantages and Disadvantages of the different Lines of Communication with our Eastern Possessions in the event of a great Maritime War."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. T. Lauder Brunton, "The Elements of Truth in Popular Beliefs."

Geologists' Association, University College, W.C., 8 p m.

Philological, University College, W.C., 8 p m. Mr. A. J. Ellis, "Reports of Dialectal Work."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Mr. C. E. Cassall, "Foods (including Milk);" "Sale of Foods and Drugs Act."

SATURDAY, MAY 7...Botanic, Inner Circle, Regent's park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. R. von Lendenfeld, "Recent Researches in Sponges." (Lecture III.)

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FRIDAY, MAY 6, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the fifth and concluding course was delivered on Monday evening, 2nd inst., by Mr. J. M. Thomson, F.C.S., the subject being "The Chemistry of Substances taking part in Putrefaction and Antisepsis."

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen for objects coming under the following eight classes:—

1. Painted glass, £25, £15, £10*.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.*
7. Hand-tooled Bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

The conditions under which these prizes are offered were printed in the last week's number of the *Journal*.

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination in London will be held by Mr. W. A. Barrett, Mus.Bac., Oxon., at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing Monday, 23rd May, 1887.

The last day on which applications can be received is Wednesday, 11th May.

Full particulars can be obtained on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Friday, April 29, 1887; Hyde Clarke in the chair.

The paper read was—

VILLAGE COMMUNITIES IN INDIA, ESPECIALLY THOSE IN THE BENGAL PRESIDENCY, THE CENTRAL PROVINCES, AND BOMBAY.

By J. F. Hewitt.

The subject I propose to treat of this evening is the history of village communities in Central and North-Western India and Bombay, both of those found among the aboriginal tribes who still retain their native customs unaltered by Aryan, popularly called Hindoo, influences, and those existing in parts of the country where Aryan social supremacy is almost unquestioned. In early times, when Governments were in their infancy, and social order was precarious, it was necessary for tribes who became agriculturists to divide themselves into unions of families, living so near together as to be able to combine at a moment's notice for the defence of their homesteads and crops, and it was thus, doubtless, that village communities arose. In many countries, the history of these communities tells of their progress amid a homogeneous race, in more it is a history of conquest resulting in the slavery or serfdom of those of the earlier settlers whose lives were spared, but in India t is, as I hope to show, the history of the

process by which several races, essentially distinct in their origin and previous training, formed themselves into united corporations of free landholders, and divided the country into a network of contiguous republics, inhabited by associated families occupying and cultivating a defined area under various forms of co-parcenary proprietorship. In carrying out this design, I hope to make it clear that the subject is one not merely of antiquarian interest, but that in studying it we gain most valuable practical evidence of the characteristic qualities of the several races who successively peopled the country, and learn by their past to estimate the part that each may be expected to take in working out the future progress of India.

The division of the country into townships, and territorial divisions containing a number of villages, is universal in all the cultivated parts of India, and can be traced back to the earliest recorded times. The place these associated townships hold as one of the most stable and settled institutions of society cannot be better described than in the following eloquent words of Lord Metcalfe, who says:—

"They seem to last where nothing else lasts, dynasty after dynasty tumbles down, revolution succeeds to revolution, Hindoo, Patan, Mogul, Mahrahta, Sikh, English, are all masters in turn, but the village communities remain the same. In times of trouble they arm and fortify themselves, a hostile army passes through the country, the village communities collect their cattle within their walls, and let the enemy pass unprovoked. If plunder and desolation be directed against themselves, and the force employed be irresistible, they flee to friendly villages at a distance, but when the storm has passed over, they return and resume their occupation. If a country remains for a series of years the scene of continual pillage and massacre, so that the villages cannot be inhabited, the scattered villagers nevertheless return whenever the power of peaceable possession revives. A generation may pass away, but the succeeding generation will return, the sons will take the place of their fathers, the same site for the village, the same position for the houses, the same land will be occupied by those who were driven out when the village was depopulated, and it is not a trifling matter that will drive them out, for they often maintain their posts through times of disturbance and convulsion, and acquire strength sufficient to resist pillage and oppression with success."

It will easily be understood, from this description, that these communities form the basis of the whole internal government of India, as far as it deals with the distribution and cultivation of the soil, but in inquiring into their origin we must recollect that, though India has been from the earliest times subject to continual invasions, and though few countries have been more frequently overrun by foreign conquerors, yet no country has been, on the whole, more conservative. The history of the progress of opinion, and of the gradual formation of the existing system of internal and social government, may be described as a record of compromises. The progress of the immigrant races who have left their mark on the fundamental institutions was gradual, and they did not, when they had gained sufficient power to assume the lead, upset the systems formed by their predecessors, and radically reconstruct society, nor were their conquests characterised by such a complete subversion of social order as marked the disruption of the Roman Empire. Each new race was content to work upon the old lines, changing only what was necessary to make the forms they found existing fit in with those of their national customs which they regarded as essential. For these reasons, the beginning of the system of village government by associated families will most probably be found in the very earliest stages of social organisation, and it is by the examination of these that we shall be able to discover whether (1) the present communities, which differ very much in their internal arrangements, sprang from one common source, and if so, (2) among which of the races from whom the present inhabitants of India are descended they originated, (3) what was their primitive form, and (4) what modifications have been added by those who subsequently adopted it.

In carrying out this inquiry, it will be necessary to place clearly before our minds the early history of India, so far as it distinguishes among the races to which its vast and varied population belong those which successively and conjointly framed the social organisation of the country, and discriminates the part taken by each in forming the land system we now find existing.

It is only a very superficial view of India which regards it as the country of the Hindoos, and thinks of the people as being of one race in the same sense the English are. The term Hindoo, though frequently used as a national name to denote those who claim to be of Aryan descent, is, when applied to the people of India generally, but little more distinctive than European when applied to the inhabitants of Europe. It ignores completely the great

existing diversity between the descendants of the successive races who have multiplied and spread themselves over the country. Some sections of these races have so far joined together as to be fairly described as the Hindoo nation, but in quite a different sense from that which we attach to the term when applied to the nations of Europe. The so-called Hindoo nation would be more properly described as a confederation of separate tribes, bound together by the interests which all people living peacably in a cultivated country, where trade is fairly active, must have in common, but kept apart by the peculiar social institutions which divide the inhabitants of every section of the country into as many tribes as there are castes.

Of the races forming this tesselated confederation, there are three which can be traced back to the earliest times, and which certainly settled in the country long before the more recent invaders mentioned in later history. First, the Mongaloid tribes of Malayan affinities, speaking languages belonging to the Kolarian family; secondly, the Australioids, speaking Dravidian languages; and, lastly, the Aryans, speaking dialects derived from the Sanscrit. Of these races, the first are now best known through the so-called Kol tribes of Western Bengal and Central India, who still hold their own several districts, and keep quite separate and apart from the Hindoos. The second are represented by the forty-six million people in Madras, who speak Tamul, Teloogoo, and other cognate dialects, and the Gonds, Khonds, Ooraons, Bhuyas, and other tribes in Bengal and Central India, who, where they still retain their native speech, speak languages belonging to that family; while almost all the upper classes throughout the length and breadth of India, and the great mass of the population in the Punjab, North-West Provinces, Bengal, and Bombay, claim to belong to the third.

In determing the part taken by each of these races in forming Hindoo society as we now find it, our only literary guides are authors writing in Aryan languages; but I hope to prove that they, as well as the legends, traditions, coins, monuments, ancient buildings, but above all, the religious history of the country, show clearly that though Aryan genius, learning, and brilliant powers of organisation, aided greatly in determining the forms into which society finally crystallised, yet that Northern Indian institutions did not grow from Aryan customs as ours in England from those of our Teutonic forefathers, but that the customs of the Kolarian and Dravidian tribes, who first occupied the country, were appropriated and altered by the Aryans, and that all these races continued to contribute their share towards producing the final result.

Proceeding, then, from the past to the present, I shall show that not only Aryan and semi-Aryan tribes divided the country into townships, peopled and cultivated by associated villagers, but that such townships exist also among those like the Kols and Ooraons of Chota Nagpore, in Western Bengal, who have always hated the Aryans, and have never been conquered by them, or subjected to their influence. I shall show, from the examples of others, in which Dravidians and Aryans confessedly live together, that the Aryan village is formed on the lines laid down by Kolarians and Dravidians, and that is only altered in certain details to make it suit with the Aryan ideas of the sanctity and continuity of the family, and of the equal rights of all holding land in the village.

The Aryans, when they entered India, were almost entirely a pastoral people, whose wealth consisted in their cattle, and who looked on agriculture and trade as degrading. Their earliest laws forbade these occupations to the two highest classes, the Brahmins, or priests, and the kshattryas, or warriors, and the latest recension of the laws of Manu, the most elaborate of the early codes, declares that "for a Brahmin or kshattrya, agriculture is blamed by the virtuous, as the plough with the iron point injures the earth and the beings in it."* With these views, their object in making a new home was not to settle down, till the land round their homesteads, and enrich themselves by labour and trade, but to find a country which, in the words of the Institutes of Vishnu,† consisted of open plains, fit for cattle, abounding in grain, and containing many *vaisyas*, or herdsmen and Sudras, or cultivators of alien race, where they might live much in the same way as the early Jewish patriarchs among the Canaanites. Such a country they found in the plains of the Punjab, where they first settled during the early period when the Vedic hymns were composed. But this comparatively populous and rich district brought with its advantages dangers which caused serious anxiety to a people who were both deeply religious and intensely proud of the purity of blood, which made them, in their

* Laws of Manu, chapter x., 84.

† Institutes of Vishnu, III., 4-5.

own eyes, the first of the natives of the earth. Among such a people the preservation of their families from intermixture with the despised natives of the country, and the correct performance of the sacrifices due to the heavenly powers they worshipped, were objects of the first importance. Hence their early codes are chiefly composed of rules regulating, in each household, (1) the ritual of the daily sacrifices offered by the head of the house to the gods and his ancestors, (2) for the maintenance of the sacred fire kindled at the wedding of the father and mother of each family, (3) the conduct of students and priests of the sacred law, (4) for the preservation of personal purity, and (5) the avoidance of marriages with strange races.

They were, in short, religious manuals composed by the priests, and intended to keep a nation, whose worship was essentially spiritualistic, from leaving their own gods and their own people, and worshipping the snake and other earth-born deities of the Dravidian races, who regarded the earth as the great productive power, and the father and mother of all things, instead of the heavenly powers, who, according to Aryan ideas, gave life to the earth and all that was on it.

In pursuance of these objects, a rigid enforcement of the rules for preserving the purity of caste became a necessary part of the priestly code, but the long lists of impure castes, formed from the union of the Aryans with the sons and daughters of the land, recorded in the early law books, show how ineffectual these provisions were. In spite of all prohibitions, the mixture of races continued, the non-Aryan races flourished, and maintained their rule over the country instead of giving way to the Aryans, and in the struggle to maintain the supremacy which the Brahmins, or priests, claimed as a right, and which they regarded as necessary for the preservation of the true religion, they were forced not only to give privileges as Aryans to the ruling tribes of the Naga, or snake races, but also to secure the acquiescence of the lower orders in that rule by incorporating their earthborn gods into the Aryan pantheon, and by fostering their family pride, by dividing and subdividing the castes, so as to make each group a kingdom apart, with its own privileges to maintain. They thus strengthened the central power of the State by rendering combinations between these separate groups almost impossible. In short, the Brahmins completely carried out the rule of *divide et impera*, divide and rule, but when they had secured their own complete dominion at the close of the long struggle, ending with the almost complete extinction of Indian Buddhism in the 8th and 9th centuries, they ruled, not over an active and living people such as that which, more than 2,000 years ago, made India one of the richest and best-governed countries in the world, but over a vast union of tribes disconnected from each other, in which all progress was stopped by the restrictions placed on individual effort and thought. The easy conquest of so disunited a people by subsequent invaders is not to be wondered at.

The Brahmin authors and inspirers of the early codes naturally cared little about the occupations of the despised tillers of the soil, and hence, in one of the earliest of them, the laws of Gautama,* we find it stated that "the laws of countries, castes, and families, which are not opposed to the sacred laws, have also authority. Cultivators, tradesmen, money-lenders, and artisans, have authority to lay down rules for their respective classes. Having learnt the state of affairs from those in each class who have authority to speak, the king shall give the legal decision." This rule which is repeated in a slightly different form in the laws of Manu,† and in the other ancient law books, is the only reference in them to village customs, and this shows clearly that they did not originate under Brahmin teaching or guidance.

In estimating the part taken by Aryans in settling and organising the government of the country, we must remember that their advance was very slow, and that history shows that, though they made their way partly by fighting, yet their skill in diplomacy was even more useful to them than their prowess in war. They gained power by sagacious alliances, by impressing on the people and their rulers respect for their abilities and reverence for their moral teaching, and by directing the policy of the ruling families as family priests rather than by actual conquest.

They remained for a very long time in the plains of the Punjab, and their first settlements were in the small territory to the north-west of Delhi, between the Drishadvati and Sarasvati rivers, called Brahmavarta, or the holy land of the Aryans, and it was not till long after they had settled there that they extended their power to the east, or gained

* Gautama, chap. xi., 21, 22, 23.

† Laws of Manu, chap. viii., 40.

access to what has been for ages the sacred river of the Hindoos, the holy Ganges.

Some of the methods by which they gradually acquired a dominating influence are well illustrated by the legend of Videgha Mathava, in the Sathapatha Brahmana, one of the earliest of the sacred Aryan writings after the Vedas, and in that of King Jamemejaya and the snake sacrifice recorded in the Mahabharata, and universally regarded as traditional history throughout India. The first tells of the advance of the sacred fire kindled in every Aryan household, from the Sarasvati, over the valleys of the Jumna and Ganges, and thence across the Sudanira, now called the Gunduk; and it shows that when the Sathapata Brahmana was written, the Aryan immigration could be described as peaceful, and more like a mission of persuasion and civilisation than a hostile conquest. Videgha Mathava, followed by his family priest Gotama Rahugana, and preceded by the sacred fire, which went burning along before them, left the Sarasvati, and reached the Sudanira. This river the sacred fire did not cross, but Mathava did by its command, and settled in the modern Tirhut, which was peopled by his descendants, and hence called the land of the Videhas. The author of the Sathapatha Brahmana goes on to say that the country was not peopled and cultivated till the sacred fire had been brought there, not by war, but by the sacrifices offered by the Brahmins. But in spite of the success of the Aryan mission, the people were not, as will be shown in the sequel, pure Aryans, and Aryan rules of life had, even at a comparatively late period, obtained a very slight hold on their minds.

The second legend † relates that King Jamemejaya fought and conquered the Takkas or the Snake races, whose capital was Tukshila, a city of the far north-west, near the Indus. That when he returned victorious he held a sacrifice of the Nagas, or worshippers of the snake, to avenge the death of his father, who had been bitten by a snake, but that he spared the lives of Takshac, belonging to the Aditya race,‡ who afterwards ruled India, and of Vasooki, king of the Nagas of Patala, in Lower Sindh, at the request of Astik, a holy Brahmin, whose mother was one of the doomed tribe, and Takshac's sister.

We see in these stories that the Aryans made their way partly by priestly influences, and partly by war and alliances, and that they had to contend against powerful States, ruled by kings of the Dravidian race, while they supplemented their successes by treaties and marriages with the alien tribes.

The story of Mathava and his family priest is one which must recall to every one who has lived long among the aboriginal tribes of India, and observed the changes taking place among them, the familiar process by which their chiefs and leading men are gradually made respectable, and converted into good Hindoos. The would-be convert secures a Brahmin as his family priest, who performs daily for him the Aryan house sacrifices in the most orthodox way. He gives largely to Brahmins, perhaps builds a temple, and observes all the rules of the Kshattrya, or warrior caste, with the greatest care. In course of time he, or at least his sons, are generally acknowledged as good Kshattryas, called Rajputs now-a-days, and marry into families of good repute, beginning with those who are so poor as to be glad to marry a daughter to a man in good position without much inquiry as to caste, or who are tempted by the offers made to break the law forbidding money to be taken by a father for his daughter. Each marriage followed by others is contracted more easily, and if the family remains wealthy, its acceptance is assured.

As for the identity of the Nagas, or Snake race, celebrated in poetry and legend as the great opponents of the Aryans and the Dravidians, I may here notice a fact which is, I believe, not generally known, and which goes far to prove them to be one and the same people. The Gonds of Central India, who once ruled the whole of that part of the country, are admitted by every one to be Dravidians, but I have not been able to find any mention of their worshipping snakes. They do, however, worship the snake periodically as the most sacred symbol of the earth as the great productive power, but the worship is kept strictly secret. In the year 1867, when I was surveying and settling rents in the Gond country of Chuttisghur, in the Central Provinces, the head *poojari*, or priest of the royal Gonds, spent a long time in my camp, and used to come and sit in my tent almost every day. Our most frequent subjects of conversation were Gond manners and customs, including their religious ceremonies. The information he gave me on these subjects was very much the same as that recorded by other

* Salhapatha Brahmana, I., IV., I., 10-1.

† Elliot, Supplementary Glossary, N.W.P., pp. 421-423.

‡ Represented by the Adityas of Malva, and the great ruling race of Kanoj.

inquirers; but one day, when he was sitting in my tent while I was writing, he suddenly, after a long silence, said, "Sahib, I have told you a good deal about our ways, but there is one thing I want very much to tell you, only I ought not to do so, as I am bound to secresy," After a little hesitation of this sort, he told me all the details of the Gond sacrifice to Sck-nag, the great snake god. This, which is the most sacred rite known to them, takes place only every seventh year, and only married and initiated Gonds take part in it. The wooden image of the god is put up under the sacred tree, and seven cocoanuts, seven pieces of betel nut, and milk and flowers are offered to it, but no animals are slain. At the same time, for the uninitiated, a goat is offered to Rajarao, one of the ordinary gods.

This solemn and secret worship strongly corroborates the evidence given by the recognition of the snake as the chief god of the race, in the name Nagpore, or "city of the snake," and other local names, and in that of Nagbunsi, or "sons of the snake," the family name of the rajahs of Chutra Nagpore, chiefs of the Ooraon tribe who have for many generations past married into the best Rajput families.

Even long after the Sathapatha Brahmana was written, there were great doubts among orthodox Aryan writers as to what part of Northern India should properly be called Aryavarta, or the "land of the Aryans." Among the early lawgivers, Buddhayana* and Vashishta† give a variety of opinions on this subject. Some, they say, declare Aryavarta to be the land between the Himalayas on the north, the Paripatra, or Vindhyan mountains, on the south, the Sarasvati on the west, and the Black Forest on the east. The last is probably the wooded region lying eastwards from Allahabad between the Ganges and the Son. Others, they say, restrict it to the country between the Jumna and Ganges, and others say it is the land north of the Vindhyan mountains, where the black antelope wanders, thus effectually excluding the land of the Vidhas, unless the antelopes have since then restricted their range, as none are found there now. Manu says this land to the far north-west between the Drishadvati and Sarasvati is Brahmavarta, and allows the second place as Aryavarta to the country between the Jumna and Ganges, the home of the black antelope, but all the rest of India is the land of the barbarians. But if the evidence of Aryan supremacy and Aryan purity of descent is weak, even in this restricted country which they would claim as their own in early times, there is abundant proof that, for many centuries after the first beginnings of authentic history, few traces can be found of Aryan rule, and that the supreme power was not vested in their kings, but in rulers of the Naga and other alien races, who were lords paramount over the whole country north of the Vindhyas, including Bramahvarta and the sacred valley of the Ganges.

India recorded history begins with the rise of Buddhism about five hundred years before Christ. For twelve or thirteen centuries from that time, till Indian Buddhism was all but extinguished by the great Hindoo revival under Kumarila and Sankara Achárya in the eighth and ninth centuries, the struggle between it and Buddhism, or between Aryan and non-Aryan aspirations and rules of life, was incessant, and forms the most important series of events in the internal history of the country. Buddhism, though founded on Aryan philosophy and ethics, is essentially a non-Aryan religion; it took its rise in the country of the Kosalus and Videhas, where its founder and greatest teacher Gautama, called the Buddha, was born. This, as has been shown above, was not an Aryan country, and though Aryans had settled there, their influence was but skin deep. The adjoining country of Magadha, the modern Behar, where the new religion prospered under the protection of its non-Aryan kings, was even less Aryan than the land of the Buddha's birth. Buddhism was made the state religion of all India by the great Mauryan dynasty of Behar, whose capital was Pataliputra, the modern Patna, and was maintained as the dominant faith by the Andhras or Sakas and the Indo-Scythians, who successively held the imperial power, and who, like their predecessors, the Mauryas, belonged to non-Aryan races. Buddhism is radically opposed to Brahmanism. It rejects sacrifices and asceticism, allows no efficacy to rites and ceremonies, no special sanctity or privileges to any class on account of birth or lineage, lays no stress on reverence to ancestors or the preservation of purity of family descent, and concentrates its whole attention on the individual, on conduct, personal effort, and the spirit by which actions are prompted and guided. Men, according to the teaching of the Buddha, far from wanting the props and stays provided by Brahmin rites and sacrifices, can and must, if they wish to attain it, work out their own

* Buddayana, I. i. 10. † Vashishta, I. 12.

salvation by self-culture. They must reap as they sow; success depends entirely on their own efforts, and they can get no assistance from supernatural powers.

Throughout the early Buddhist writings the Aryan gods are scarcely mentioned, and though the minds of the authors are evidently saturated with the moral and metaphysical speculations of the great thinkers of that age, so rich in mental activity, there is no arguments against Brahmanism and its accompaniments, except the general denunciation of all teachers, whether Brahmins or not, who prescribe asceticism, reliance on ceremonies, and the favour of the higher powers as a cure for human ills. The Naga, or snake gods, are mentioned much oftener than the Hindoo deities, and are always spoken of with a certain amount of reverence, while the sacred symbols of the snake and the tree are conspicuously present on all the carvings and bas-reliefs which adorn the walls of the ancient Buddhist buildings.

Buddhism maintained its supremacy unquestioned from the time when the great Emperor Asoka made it the State religion, between 256 and 222 B.C., till the rise of the Gupta dynasty, about the fourth century of our era. The faith, however, did not remain unchanged during that time, or the subsequent period of the struggle with Brahminism, but the chief leaders in the successive movements were not Aryans, but Nagas, as their names, Nagarjuna and Asunag, show. Nagarjuna, about 150 years before Christ, introduced the doctrine that salvation can be obtained, not only through personal effort, but also through the accumulated merits of the saints and super-celestial beings, who, inspired by love of the human race, appeared from time to time on earth as Bodhasats, or saviours of the world, to deliver men from the consequences of ignorance and sin. This teaching rapidly opened the way to a return to the old belief that an easier road to heaven might be found through rites and ceremonies, charms and incantations, than the life of strenuous exertion prescribed by Buddha, and to the consequent neglect of the wholesome moral teaching which formed the essence of his doctrine.

During all this time, Brahmanism, though not the fashionable religion, was by no means dead, and when the Brahminical revival began under the Gupta dynasty, the assimilation between the two antagonistic faiths went on more rapidly than before. Early in the sixth century, Asunag, an influential monk of Peshawur, in the Punjab, introduced the Saivite gods of the old earth-worship into the Buddhist heavens, representing them as the worshippers and supporters of the Buddha and of his celestial counterparts. When these were once admitted, the return of sacerdotal influence was not long delayed, and though Buddhism, during the transition period between the beginning of the Gupta rule and its final suppression, was alternately tolerated, actively supported, or fiercely repressed, by the ruling powers, yet Brahmanism was throughout increasing in authority, and attaching to itself more and more general support. The Brahmins astutely accommodated their system to popular prejudices, restored the supremacy and worship of the old earth-gods, under the form of Saivism. They introduced a special festival, the Nag Panchomi, in honour of the snake god, and incorporated the whole doctrine of the salvation of men by the appearance on earth of the Bodhasats into the mystical creed of Vishnuism. Among the incarnations of Vishnu, Buddha was introduced as an appearance of the god of the earth, and the new teaching was tolerated as a development of his doctrine. The series of Puranas which embody these changes disclose a much more popular form of religion than that set forth in the stern teachings of the Buddha or the proud Brahmanistic isolation prescribed in the earlier rituals. Simultaneously with these changes the caste system, which was all but ignored by genuine Buddhism, was made more rigid than in early times, the royal authority was strengthened by the popular methods described in the early part of this essay, and the triumph of Brahminism was complete. The above rough and necessarily imperfect sketch of the early history of India shows what an important part was taken by the non-Aryan tribes in forming Hindoo society as we now find it, and how, even in the religious and social questions which chiefly interested them, Brahmin diplomacy and finesse had to incorporate non-Aryan beliefs with their own before they could establish the system of law and order which embodied their ideas of what was right and fitting. I have shown that it was the non-Aryan races who first came into the country, cleared the forests, cultivated the lands, built the towns and cities, established trade, and formed a strong and stable government, and that the Aryans only modified the system they found existing to suit their national customs.

I shall now show that the first village com-

munities were formed by non-Aryan races, and that when the Aryans settled in these villages, or founded new communities, they retained the organisation of their predecessors, only altering it so as to make themselves the village rulers, and to adapt the laws regulating these associations to the rules of the Aryan family.

In order to determine the non-Aryan people who first founded these communities, we must examine the institutions of the agricultural tribes of the earliest immigrant races who still keep their primitive customs intact. No one who has studied this question in Central India and the western part of Bengal, called Chota Nagpore, can have any doubt that in these regions the forest tribes of Kolarian origin were the first settlers. They claim to be so, and no one denies their right. They can still be traced westwards from Chota Nagpore, occupying parts of their former settlements, and generally living on the most inaccessible hills and least fertile soils. In the Central Provinces we find tribes like the Kurkoos of Hoshungabad, who speak the language and retain the customs of their forefathers, and others are found in every stage of transition from nearly pure Kols to low caste Hindoos. Even in the cultivated parts of Bombay traces of them appear, and if the Kolis of Maha Kanta belong to this race, they still retain a separate organisation of their own, even in this far west region. It is, however, in Chota Nagpore that we now find the largest tribes who have remained unaltered by contact with other races. The Ho and Munda Kols, who now hold what must have been very early settlements of the race in their progress westward from Arracan and Burma, have, instead of submitting to invaders, maintained themselves as a separate and distinct people from the earliest times. Their settlements are on the lower levels of the Eastern plateaus of the Vindhyan range, and they thus remained for a long time undisturbed by invaders from the West, to whom the large area of difficult and unpromising country to be traversed before their settlements were reached offered few temptations. In this secluded but fertile country they were able to form a fairly strong and united government, and thus to defend themselves, when attacked, better than the more scattered tribes in the West, who had not planted their roots so firmly in the soil. The Hos of Singhbhum have always remained independent, and though the Ooraon and other immigrant Dravidian tribes have settled in the Munda country; tradition says they were admitted peaceably. They imposed their own organisation on the Munda villages to the west, but left those on the east undisturbed, and under these conditions the Mundas seem to have accepted the Ooraon and other Naga leaders as supreme rulers of the country.

But besides the Mundas and Hos, we find in the forests of the hill state of Sirgoojya, to the west of Chota Nagpore, the Korwas, a much more primitive Kolarian tribe, who are still partly wanderers in the forests, occupying temporary clearings, and partly a fairly settled people, living in fairly permanent villages, under hereditary chiefs.

The Korwas are like the rest of the Kols, a totemistic people. Each clan of the tribe has, as its distinguishing totem, some natural object, which is reverenced by its members, and marks distinction of lineage. When the totem is an article of food none of the clan may eat it, and as no one can marry in his own clan, every man seeking a wife must make his choice out of the girls of families with different totems. When they cease wandering in the forest, and form more permanent villages than those occupied for one or two seasons by the nomad septs, these are generally founded by families having the same totem, who live as they used to do, near together, and the villages occupied by the several clans of the united section of the tribe, find their centre of union in the Byga, or tribal priest, who, besides offering common sacrifices to the sylvan deities for all the confederated clans, is generally arrow maker to the community. The heads of the clans are chosen from those who gain the greatest influence over their fellows, but neither these offices, nor that of tribal priest, is hereditary or necessarily permanent, all are dependant on popular opinion, which may any day reduce the holders to the level of the ordinary tribesman.

Even among those Korwas, who live under hereditary chiefs, ruling comparatively large territories, the villages are not ruled by hereditary headmen, nor are village boundaries carefully defined, though those of the chieftaincy are well guarded.

On passing from the Korwas settlements to those of the Munda and Ho Kols, we find a much more settled state of society. The parha, or tribal territory, under a hereditary chief called manki, is still the most important territorial division, but each parha is divided, in the more cultivated parts of the

country, into townships, and each township has its local deity or deities, called Desauli, to which common sacrifices are offered by the villagers. The Desauli is not the earth god of the Naga races, but the local spirit or spirits of that part of the forest where the village clearing was made, for whose residence a few trees of the old forest are always left.

Each village has its priest, but the office is not hereditary, nor more permanent than among the Korwas. He is paid, not by a grant of land, but by dues from the villagers. The only hereditary village office is that of the munda, or headman, but the heads of families representing the first settlers have always a great deal of influence in it, and can often manage to depose the munda, and choose another of the same family, or, in extreme cases, select a man belonging to one of the families of the original settlers. The munda, though always a landholder, holds no land by virtue of his office; what he holds is his private property, but he disposes of all lapsed or abandoned land, and generally manages to get the best land for himself.

Villages are enlarged by the cultivators forming clearances in the neighbourhood, which either remain as tolas, or hamlets of the parent village, or, in process of time, become separate villages. Each hamlet chooses its own headman, who acts in concert with the village munda, but he does not obtain hereditary rights till it is formed into a village.

The mankis, acting in council with the mundas and chief tenants of the villages, govern the parha, and the final appeal in all cases lies to the manki. They are generally mundas in one or two villages in their jurisdiction, but receive no revenue from the subordinate mundas, except small contributions of grain, and game killed in hunting. There is no trace in the Kol system of government of the existence or a king, or any power above the mankis, and the united assembly of mankis, mundas, and chief tenants. They regulated all matters within the tribal territory, but it was only by negotiation, or war, that questions between adjoining tribes could be settled.

The clearing of a country by the Kolarian tribes must have been a very slow process, as, though they were an inventive race, and had early learnt the use of iron, their tillage was, till they came in contact with the pastoral tribes, very primitive. They always hoed the land, as they were ignorant of ploughs, and the use of plough-cattle. Even now, when they keep cattle, they only keep enough for purely agricultural purposes, as they never drink milk, and oxen are too valuable to be used as food.

That this land system is of indigenous Malayan origin is rendered extremely likely by its similarity to that now found in Malayan countries. In Forbes's "Wanderings of a Naturalist in the Eastern Archipelago," I find an account of the country of the Lampoongs in Sumatra, which answers exactly to the above description. The country is divided into margas, each under a supreme chief, and each containing several villages, each village having its own chief. Villages are divided into sections called sukus, and while the headship of the village and margas is hereditary, each suku elects its own chief. Appeals from the village courts lie to the head of the marga. Here we find the marga answering to the parha, its chief to the manki, the head of the village to the munda, and the chiefs of sukas to the heads of kolas or hamlets.

In Chota Nagpore we can not only trace the gradual advance in civilisation of the Kolarian tribes without finding their customs altered by contact with other races, but we can also in the same province compare the mixed Moonda and Ooraon villages with the original Kolarian types, and thus ascertain the changes wrought by Dravidian influence.

The Dravidians who entered India from the west are, as we have seen above, celebrated as the principal opponents of the Aryans, and they are apparently allied to the race described in the early Persian writings as worshippers of the demons and great snake Azidahaka. They were essentially a ruling and thoroughly practical race, who believed firmly in the necessity of a strong central government to maintain order and unity. They sought in their slow and steady advance through India fertile lands, where they could live in peace; they did not, however, in their search divide themselves like the Kols into small parties and tribal unions to clear the forests, but moved in large masses like an army. Hence they preferred to settle in lands which had been already cleared. They were accompanied by their wives, children, and property. They were not mere raiders eager for booty and careless of the destruction they wrought, nor did they wish to fight, though they were quite ready to do so if fighting were necessary to obtain the land they required, and when there was space enough for themselves and the earlier inhabitants, as was the case generally

in India in early times, they were quite ready, after taking the best lands, to leave the remainder for those who preceded them. As a rule, they and the Kolarian races seem to have arranged to live together without serious differences.

When they settled in a country, they formed their government on the model of their camps, placing the central provinces under the king as general in chief, and assigning the outlying districts to the subordinate chiefs who, with their respective forces, were appointed to guard the frontiers. When fresh expeditions were prepared to occupy new countries, they were organised in the same way as that by which the present homes of the colonisers had been acquired, and they occupied the new country as they had done that they left. In this way they gradually spread themselves across India, and the boundaries of their several kingdoms can still be traced in countries so little altered as Chota Nagpore, and I believe also in Chuttisghur, in the Central Provinces; and though they have been to a great extent obliterated in the more populous parts of the country, I believe they could to a great extent be reconstructed by careful inquiries on the spot.

In territories occupied and settled before their arrival, like that of the Mundas, in Chota Nagpore, they took the old parhas as the provincial division of the kingdom, only massing several parhas together where a large province was required.* But the old parhas can still, where the Kol organisation is preserved, be traced through the distinctive flags which each retains, and which are conspicuously displayed at all public gatherings.

The training necessary to secure the united action of all members of the nation was begun almost in childhood, and in every village young men and girls were separated from their parents when they were little more than children, and obliged to live in separate lodgings, the young men in what is called in Chota Nagpore the *dhumkuria*, or bachelor's hall, under the care of one of the elders of the village; and the girls in another similar building superintended by one of the matrons. They were there supposed to be instructed in their future duties of serving the community and obeying its leaders.

Among them, as among the Kols, each clan had its totem, and only families having different totems could intermarry. Like the Kols, they offered sacrifices to their ancestors, and their feelings of proprietary right in the lands held by their forefathers was, among the families with privileged rights, stronger than among the Kols. Members of these families believe firmly in the indefeasibility of these rights, and I have met Ooraon cultivators who had lived all their lives, and held lands in villages beyond the limits of their own country, who named to me the villages where their forefathers had owned lands, and which they had never seen, and believed firmly in their right to return and claim a share in these lands, should they wish to do so.

But their feeling as to individual rights and claims was weaker than their wish to have an efficient government. In a well ordered and populous country they were careful that the village organisation should be strong. Where the populations were sparse, and the villages small and scattered, they thought more about the provincial and central than the village government.

When the Ooraon chiefs became rulers of Chota Nagpore they retained the parhas and townships they found existing, but the democratic Kol constitution did not satisfy their views as to what a government should be. They could not understand how a country could be kept in order when each village formed a unit apart under its own headman, when it paid no taxes or contributions to the central government, and was only bound by the traditional rule of obedience to the manki.

According to Dravidian ideas, the central government must not only be maintained by contributions from the villages, but it must be represented in each village. Hence a certain proportion of the best land, called manjhus land, varying in area according to the size of village, was set apart for the service of the raja or king. The produce of this land was either stored in the royal granaries or, when the village was assigned by the raja to a subordinate, made over to the assignee. The rest of the land was divided into allotments, called koonts; three of these were assigned to the families who received the right to fill the village offices. All these offices, and not merely that of the munda, as among the Kols, were made hereditary. They were called bhunhiars, and were chosen from the original settlers.

One of these allotments was set apart for the munda, or headman, but he was no longer supreme in the village. He divided his authority with the pahan, and with a new officer appointed by the Ooraons, the mahto,

* As in the home province of Khokhra in Chutra Nagpore.

or accountant, who held the two other allotments.

The pahan had still to perform the sacrifices necessary to satisfy the forest spirits called Desauli and the distinctive village god; but their chief function was to make offerings to the great earth-god worshipped by the Naga races. The division of the pahan's lands shows the relative importance of these three functions. The largest tract, called "Dalikhatari," a holding found also among the Gonds in the Central Provinces, was set apart for the worship of the earth-god, and the smaller plots, called "Desauli bhut kheta" (the field sacred to Desauli), and "Gaondeoti bhut kheta" (the field sacred to the village god), were appropriated to the worship of the village "bhuts," or spirits.

The mahto, or accountant, was probably originally appointed to look after the rajah's Manjhus land, and to see that it was cultivated by those holding land in the village who had no ancestral rights to the village offices. This was probably the only form in which the tenants were at first taxed, but afterwards, when they were called on to give contributions in grain in proportion to the size of their holdings, a plot of land, called "beth kheta," was assigned to them, free of revenue, to pay for their labour on the royal lands.

These tenants had a right to a certain area of cultivated land, proportionate to their ability to till it, outside that allotted to the office-holding families, and generally on the admission of a new tenant, the cultivated land was re-distributed, so as to give each cultivator a portion of each kind of soil in the village, calculated according to the number of plough bullocks he had. In large villages the heads of the families, who were the oldest settlers, had a great deal of power, and formed part of the village council. They were always consulted before a re-distribution of land was made, or a new tenant was admitted. The privileged families paid no taxes in grain, or afterwards in money, but gave general suit and service to the ruling authorities, carried their baggage on a journey, supplied them, as well as travellers, with wood and grass when they visited the village, thatched and repaired the houses and granaries of their chief, looked after the village boundaries, and kept order in the village.

The subordinate village officers generally paid in grain, though sometimes in land, were the water carrier, who was also the pahan's assistant, and is found in every village; and beside him were others, generally common to more than one village, viz., the blacksmith, the potter, the cowherd, the barber, the washerman, and the watchman. There was also in every parha the ojha or sorcerer and witch-finder, a most important office in a country where every unpopular person is at once denounced as a witch or wizard. The ojha was credited with special powers over evil spirits, and especial ability to detect those who had unlawful dealings with them.

We have already seen how the process of amalgamation between the Aryan and non-Aryan races in religious and social organisation was effected, and I have to show how it was worked out in the village community. As I have just now stated, among the Kols the parha or tribal union under the chief, and among the Dravidians, the districts ruled personally by the king or his subordinate generals, were the first divisions of land adopted. The next step was to divide these into villages and townships. The villagers among the Kols chose their munda or headman, but the Dravidian village was placed by the central authorities, under the mahto or manager of the royal land, and the families selected by the villagers to fill the offices of munda and pahan, or village priest.

Aryan settlers, who regarded agriculture and every kind of service, except that given by the priests and warriors, as unworthy of a free man, and who were especially anxious to keep intact the family and the property which kept those belonging to it together, would not stoop to fill the village offices in a Dravidian State with their accompanying obligations to service which they looked on as menial; nor did they care to hold land on a shifting tenure, subject to change on every redistribution of the soil. They were, however, ready to become villagers' headmen, provided that they had only, like the Kolarian munda, to act as chief rulers and arbitrators in disputes, and were also willing to work as accountants and collectors of the revenue. Consequently, in the Aryan village, the Patel or headman, to whom the royal land was assigned as his appanage, and the accountant, remained the chief village officers, but the land was divided into defined allotments, each of which was assigned as the property of a cultivating family. The village priest, if he was retained, which was seldom, was relegated to a very subordinate position among the meaner officials, while the power of the ruling village officers was diminished, that

of the chief land-holding tenants was increased, as they formed, after the headman, the most important members of the village council, but instead of giving personal service or assisting in the cultivation of the royal land as among the Dravidians, they paid their share of such contributions as the village was required to give for the public service.

A most interesting description of the village communities in the Bombay Deccan, written many years ago by Colonel Sykes, in the *Journal of the Asiatic Society*,* shows how the Dravidian and Aryan systems worked side by side. This country once formed some of the richest provinces of the great western kingdom of Malwa, of which the great Vikramaditya, emperor of India in the sixth cencentury, was the most celebrated king. It was under his rule, and that of his predecessors and successors, one of the chief centres of national activity, both during the time when Buddhism was dominant, and the transition period of its contest with Brahmanism.

The leading cultivators in the Deccan village all claimed to be Aryan Maharattas, but the only hereditary offices they held were those of patel, or headman, and kulkarni, or accountant. Only the headman held land in virtue of his office, and had the right of giving clearance leases of waste land, while he and the chief tenants, who were members of the village corporation, had the right of disposing of abandoned lands. The accountant, who was generally a Brahmin, was sometimes paid in land, but generally in money, and contributions of grain. The office was hereditary in certain families, each family taking it in turn for one year, and not by lot, or election, as among the Kols and Dravidians. The land was divided into allotments called thals, or jathas, each being assigned to a separate family, and called by its name. This name remained attached to the land, though the family had left the village, and the land passed into other hands.

But besides the Aryan tenure holders there are also in each village families of aboriginal descent, known as Mahrs. They held lands or tenures precisely similar to those of the Bhunhiars or principal tenants among the Ooraons. Their former power had, with the adoption of Aryan customs, passed into other hands, but they still held their hereditary land at a low quit rent, paying for it as their forefathers had done, by the same personal services to the community which the Aryans thought degrading, but they considered as honourable. They worked gratuitously for the head of the district, supplied wood for fires and grass for horses, and baggage animals to government officers and travellers visiting the village, acted as guides and porters, carried baggage, and went as messengers. They still remained as heretofore guardians of the village boundaries, and referees in boundary disputes, and still acted as assistants to the headman, as they had to bring the villagers together to pay their revenue, and carry it, when paid, to the collector of the district.

We also find in the Central Provinces a transition stage in the village community between that described in Chota Nagpore and the mixed Aryan and Dravidian village in Bombay. There, as elsewhere, the parha or tribal territory, known locally as the talooka, is the limit of territorial division. In the wilder and more remote parts the village organisation is very weak, but in such districts as many of those in the Nerbudda valley, where the division into townships has existed from time immemorial, the villages show their antiquity and permanency by the comparative completeness of their system of government. In Hoshungabad* we find that in the greater number of villages, the headmen are Brahmins or Rajputs, and the village accountant is generally a Brahmin, but the older races are not so universally dominated by Aryans as elsewhere. There is a general feeeling that Hindooism, under Brahmin supremacy, is a mark of respectability, but the family is not so prominent as in Aryan countries, and the village priest, who takes the lead in the ceremonies of the worship of Machundri, the great earth goddess, is so important an officer that the accountant, where he was not a Brahmin, sometimes consented to combine the two offices in his own person. In that case the priest becomes like the Ooraon Pahan, one of the chief powers in the village. In Hoshungabad, the Kurkoos, a Kolarian tribe, are also found acting as village watchmen and assistants to the headmen in one part of the district, and it may be said generally throughout India that these officers belong always to one of the aboriginal tribes or to one of the low castes, calling themselves Hindoos, but following the customs of their aboriginal forefathers. In the North-West Provinces, where Aryan influence has long

* *Journal of the Asiatic Society*, vol. ii. p. 208.

* Elliott's Settlement Report, pp. 64 and 127—134.

been more powerful than elsewhere, the special rights and privileges once enjoyed by Dravidian cultivators seem to have, to a great extent, disappeared, and the village has become either a semi-feudal tenure, in which single or joint proprietors govern the cultivating body or a proprietary brotherhood, in which the lands are held either in common or severalty by the cultivating families, each family paying its share either towards the total revenue paid by the villages, or that portion of it due by the section to which he belonged.

Among all the changes that have taken place in the parts of the country mentioned by me this evening, we find everywhere the original division of the country into districts, and the further subdivision of all cultivated and populous districts into townships still existing. We find also the village headman everywhere, and I believe I may say safely the village god; and the village accountant is, next to the headmen, the most important officer of the village. The boundaries of the townships are preserved with the greatest care, and are always under the charge of the aboriginal races of the lowest castes, whose forefathers fixed them.

The village priest in Hindooised districts has, if he has not disappeared, lost his ancient powers, while in the Aryan village, the promotion of the general body of the cultivators to the prominent position they hold in the democratic Kolarian constitution, has resulted, not in the instability of the Kol tenure, but in the permanence given to the village, by the proprietary rights acquired by the cultivating families in defined plots of land under the Aryan rule of family property. In Dravidian villages the privileged classes alone had these special rights, which were given by the Aryans to all families admitted into the community.

It was villages thus divided into contiguous allotments, named after separate families, and known for centuries by the names of those who had first acquired the proprietary right, which became the compact and permanent associations, described by Lord Metcalfe, and though it was the aboriginal races, and especially the Dravidians, who first formed the framework of the village, and organised it as a distinct and separate unit, it was the Aryans who enlarged its area and solidified the proprietary rights of all the cultivators, so as to make each member of the community feel that his ancestral home and property were within its limits, and that each all were bound together by reciprocal and obligations of help and defence, and by the possession of a common property.

DISCUSSION.

Mr. W. S. SETON-KARR said that there appeared to be in all accounts of early migration rather a tendency to go a little behind the evidence, but, in his opinion, any deductions must necessarily be imperfect. He quite admitted that, during the last few years, owing to the inquiries into ethnology and philology, the study of early sculpture, and the writings of well-known scholars, these problems had been made more or less familiar, and gentlemen who studied the subject were in a much better position to make any deductions than they would have been 30 or 40 years ago. Still, after all, many conclusions must to a great extent be hypothetical. All that had been said by the reader of the paper was extremely valuable and interesting, and no doubt in Central India he had studied the subject on the spot, and had thus acquired a minute knowledge of village customs. He should have been glad if some information had been given by Mr. Hewitt as to the village and social life of the Kolarians and Dravidians, and the way in which the revenues were collected and paid, and their customs and forms of worship. He quite agreed that the Kolarian language was separate, but he was not clear as to the migration of the Kolarians and others who had disappeared before the Aryan invaders. Manu had laid it down that the land of the black antelope was the proper place for the Aryan to live in; but he had always understood from Orientalists that this rather meant that the Aryan first took possession of the wide and open plains of Upper India, when the lower tribes who preceded them took refuge in the jungle. The black antelope did not live in the hills and jungles, but in large plains. The subject was a very difficult one, and no doubt Mr. Hewitt had had greater opportunities of studying it than he had, but he (Mr. Seton-Karr) always understood that the first Aryan settlement was between the Rivers Saraswati and Drishadvati. The Aryans worked their way down, and ousted the former residents, who took up their residence in the mountainous districts and jungle. The subject was one which opened up a wide field for inquiry, and was one on which gentlemen might fairly differ in opinion as to the right and proper conclusion.

Mr. E. KIMBER said Mr. Hewitt had described the races of India as forming a tesselated confederation, and this he thought aptly described a happy state of society. The tribes had been described as being weighed down with misery and poverty, and an unbearable local tax, but it appeared, from the description now given, that they positively had republican institutions, and were in such a happy state that the village

communities of England might envy them. He should have been glad to hear something about the cess tax, because not only in that room, but in other places, they were in the habit of hearing that the cess tax was a most iniquitous thing. In England, in former times, there was a system analogous somewhat to the Indian village communities, when manorial courts were in full swing. He presumed the cess tax would be collected from certain areas; these areas would have boundaries, and the boundaries would have had a certain existence, in point of time, perhaps, for many centuries. He thought it would be found if the boundaries of the different taxable areas could be traced from generation to generation, that by this means they would find out more surely than by any other the mixture of one community with another, and the variation of one from the customs of others. One of the most interesting investigations which could be pursued in this country was to ascertain why a certain old road, or common, or village land, which had existed with certain boundaries, had been destroyed, and this could, in most cases, be easily ascertained from books in the British Museum, and the boundaries, in some cases, traced to as far back as the DomesdayBook. By the same means in India no doubt they would be able to ascertain the boundaries there. It was not improbable that the boundaries of different village communities and village lands in India had an existence even 2,000 years B.C. He did not know whether he was quite correct, but that was the presumption he gathered from all the history which he had been able to read upon the subject. He quite agreed that the proper government of India, the cess tax and the like, depended upon a knowledge of the proper boundary, and he should like to know how those taxes were collected in former times, and how they were collected now.

Mr. G. L. Gomme thought that one of the lessons they might learn from the paper was that the present rulers of India were not likely to make the serious mistakes which were made in the early days of the conquest. These mistakes were not made through any wish to make them, but simply through ignorance. When an English settlement officer went over there, he immediately looked upon the headman of the village as equivalent to the lord of the manor in England, and the consequence was that wrong was done by transferring land which belonged to the community so as to make it the property of individuals. When in England they had the example of a settlement officer coming and giving them such very important details of the village community of India as they had had that night, they might rest assured that in the future England would not be allowed again to make those very terrible mistakes. He had been a student of village communities for some years, more especially with regard to England, and had been much struck with the very definite evidence there was of racial influence, and he was particularly interested when he found that that was also the case in India. But the paper showed us that among the non-Aryan communities there was a distinct development—that is to say, among the Kolarian and Dravidian villages. There were types, first of all, where the communities were found settling down within a certain area in the forest with no definite organisation; and, secondly, there were types with village officers and customs. If, therefore, development took place among non-Aryan races, why should they suppose that the subsequent alterations were to be attributed to the Aryan races only. He might give an instance of what he meant. Among the Fijians they had a distinct and definite system of land owning, very similar to the Aryan village community, and yet he supposed among the Fijians no Aryan influence had come to make up that system of land holding. In Ireland they found very distinct traces of a type of village community very similar to the non-Aryan types of India, and in districts which were held by the Danes they found a tightening, so to speak, of the looser village customs into something definite, such as was ascribed to the Aryan races. Therefore, it appeared to him that all the variations in the village community should not be attributed to racial influences, but that something must be ascribed to necessity. One feature brought forward by Mr. Hewitt was the absence of the plough. In Shetland they also found the absence of the plough, but that was due to the fact that was of no use there, and it could not be said that because the plough was absent there that it had anything to do with race. A great deal of the variation of type and custom of the community was due as much to necessity as to race. One very remarkable instance which he found in England of a village community was at Malmesbury. There he found distinct evidence of the tribal community of a very loose organisation, and after the Danish occupation of the district he found a tightening of that organisation into something more definite and better organised. This showed that in that district one race had operated upon the same object at different times, and the result had been an alteration of the early types. This again suggested to his mind that although there could be no doubt that Mr. Hewitt had established certain phases in the history of the village community, yet they were not always to be attributed to race, but sometimes to necessity. Such a subject as this, bearing so intimately upon our dominion in India and the history of our country, could not be too widely supported, and he was sure the meeting was sincerely grateful to Mr. Hewitt for his paper, which must in the end throw light not only on Indian but also on English history.

Dr. Pringle had been much struck with the concluding portion of the paper, for, after all our governing of India, we had now, it would seem,

gone back to something very original, there being a wonderful connection between the headman and the chokadar of old, with the same functionaries at the present day, and they at the two extremes of the village community. In one thing only they differed in olden times, there seems to have been no money lenders in those earthly paradises. The amount of information which the chokadar in the present day is supposed to possess baffled all description, and this for a rate of pay which, including perquisites, was incredibly small. When in India he had occasion, as medical officer, to accompany the troops against some insurgents, and passed through the Khond country, from inquiries he made in the villages, he found distinct evidence of systematic human sacrifices, among the Meriah victims themselves. These Khonds know nothing of a God of love, and their great aim was to propitiate the evil spirits by human sacrifices. Whenever the crops failed, one of these Meriah boys, who had been taken prisoner or purchased, was killed by the headman, the expression being, "It is not murder, you were bought at a price." After the sacrifice, portions of the flesh of the victim were buried in the fields, with the idea that the evil spirit would be propitiated, and the crops would be good. The last sacrifice which he knew of took place about five years ago. It was evident that snake worship was practised by all castes of Hindus, on account of the universal aversion they all had to killing this reptile. He thought the absence of the plough which had been referred to was due to the fact that it was not wanted, as evidences of an abundance of iron were present in these hills, and the Khond knives and weapons were made of iron. Some remark had been made about the Government of India, what it had, and had not done; he must say that, from his recollection of these Khond villages, as he saw them in 1855, in their positively primeval form, there was nothing which could be more simple and primeval, and yet, in the villages in the North-West Provinces, notwithstanding all the civilisation they enjoyed, the sanitation in nearly every case was simply dreadful, and this was a matter which ought to be remedied. As evidence of the progress of civilisation in India, he might refer to the fact that now on the village tree, in nearly every village, there was to be seen a little red box, hanging from a nail or branch, upon which was cast the Royal Arms, and he heard a story of a native who put a letter inside this "portable post-office," and then offered up a prayer, in the hope that the spirit inside the box would see that the letter was delivered to the proper person. The natives were most grateful to the Government for having provided this means of communication between one another, and to the fullest extent availed themselves of the benefits of the cheapest postage in the world.

Mr. CHARLES BOULNOIS thought that, in attempting to found an hypothesis that the Indian village was derived from non-Aryan races, there was a considerable body of evidence to be displaced, and although he wished Mr. Hewitt all success in his undertaking, it did seem in some respects a rather difficult task. The Indian village was supposed to stand in close parallel to villages in Central Asia and Russia; but although for India they might have a theory to the effect that an Indian village being anterior to Hindoo law, and to those ancient Hindoo laws which treated of it indirectly, so as to found a doctrine that it came from the ancient Dravidians and other non-Aryan races, it would be necessary to show a great deal more than had yet been brought before their notice. That there were ancient races in India could not be denied, but it was a large assumption to say that the village system came from the southern districts of India, or that it was from the south that all ideas of order and good husbandry came. It might be that those who were more familiar with Northern India had rather taken a flattering view of the provinces with which they were most acquainted. That the village system went from the south to the north appeared contrary to the fact, and it was contradicted by the fact that in the north the best forms of village system were still found prevailing. In the south the village system was comparatively weak, and was almost swept away by Mohammedan invasion, being found in its strongest form in the neighbourhood of Delhi. Sir George Campbell, in his essays on land tenure, had described it as the strongest form of freehold joint property, and it had also been described by Lord Metcalfe, in the quotation read by Mr. Hewitt, as a little republic. These little republics survived to the present day, and it could not be said that the Government of India had ever shown any but the greatest solicitude to fence them round in every way. It was a most remarkable thing in the history of our race that the people untaught should have preserved the most complete rights of property, for the purpose of association with one another, of holding property —that they should respect these rights without any tuition and without any rulers. They had rules so clear, and yet at the same time so numerous, that it would be utterly impossible for any one to attempt to deal with them in one paper. One of the most remarkable ways in which the working of the village system was shown was, when on the banks of a river, they divided the waste lands without the interference of an officer; it was done by a process something similar to the instinct of bees. Village communities had been expressly considered and reported upon in many works undertaken in the Revenue Department of the Government of India, and he thought the paper to which they had had the pleasure of listening that evening might be considered as a contribution to a very difficult subject.

The CHAIRMAN said those present had been convinced, as well by the paper as by the discussion, that the subject was one of practical importance. Some might think that portions were hypothetical,

but then it was necessary to take into due consideration the comparative evidence which had been brought to bear, or which interpreted or filled out the meagre facts preserved in India. He would call their attention to one point as an illustration. Mr. Hewitt had told them of serpent worship among the Gonds, and of what was secretly held by the Gond priest. He stated that the snake was worshipped, and a goat was sacrificed. This runs parallel with the narration of Sir Spencer St. John as to Hayti, and the Vudu rites there, and of the Vudu rites among the negroes of the United States, described by Mr. Charles Leland (Hans Breitmann). The Vudu snake rites are secretly kept and secretly celebrated, and the goat appears there. The great mystery that is revealed is that the true goat is a human sacrifice. The Vudu rites of the west are derived from Africa, and in some of the languages of that region snake and goat are the same root. If, too, other facts constituting the evidence are examined, they will be found to be not of local import, but a part of the patrimony of mankind. Notably as to languages, the words of the Mundas, the Kols, the Dravidians, the Nagas of the Hills, will be found repeated in Africa. In some cases a hundred or two hundred words of parallel vocabularies can be identified. The method of Mr. Hewitt was practical and formal. He took the aboriginal and Aryan tribes as the first occupants of India, who had brought it into a settled state, and founded the existing institutions, though we were not compelled to acknowledge a Malayan origin. First he took the Kols, then the Dravidians, and afterwards the Aryans. He had not dwelt on the Nagas, who represented ancient rulers of India, and whose languages and institutions were connected with those of ancient culture. The history of India was thus brought into conformity with the written or recorded history of the better known regions. We find the names of the cities of India the same as in the classical maps; we know the eastern people were exogamous, marrying out of the tribes, of which the latest example in the west is that of the Picts in our own island, which remained till the Norman accession. Bede expressly says the Pictish kingdom passed by female descent, and the chronicles confirm it. The village communities of India were stated to have been composed of separate families or tribes, as some of them are now, and such they were originally in the classic world. The Kolarians appeared to represent the original inhabitants of Babylonia, and the Dravidians the Akkadians. The Semitic and Aryan invasions introduced new languages and new religions there, but the former populations remained, as in India. Mr. Hewitt showed that the Aryan occupation of India did not correspond to such invasions as those of the Gauls and Germans in Europe, but that they were due to quiet advance, consequent on religious propaganda, and the influence of a uniform language. The mode of Aryan advance in Hellas and in Rome does not appear to be due to conquest, but was aided by the undermining and fall of the earlier preponderating influences. It appeared to be desirable to recognise in India the alternate struggles of two systems of religion or fetishism, both described as serpent rites. They were those of Vudu and of Saba, figuring later as Buddhism and as Brahminism, the latter bringing Siva or Saba into the pantheon. These sects modified from time to time their higher doctrines of pantheism or monotheism, and their lower practices of sacrifices and demon worship, as successive apostles presented themselves, or as they succeeded in enlisting some popular sentiment or superstition. Mr. Hewitt brought us to the practical result of his investigation by showing that, in providing for the government of Hindostan, we had to give up the nation of Hindus which had been so imaginatively pictured to us. He dwelt on the fact that the people of Hindostan did not constitute a nation, and they were not bound together by common descent, or common language, or even an identical religion. The many nationalities still distinct, or partially Hinduised, really required protection at our hands, as did their various vernaculars. If the Hindus who claimed to oust us in India were invested with the supremacy they claimed, they would persecute the aboriginal rites, and set aside the aboriginal customs. They who had been conquered by successive invaders would be conquered by the Musselmans and the other populations, who held them in hatred and contempt. To govern India we required to know who the people were, and what are their real conditions and requirements. Under English rule, the people were receiving protection, and their independence was respected. The public, at a time when the prosperity of India was greater than at any historical period, were told that the people were oppressed and impoverished, and that the government of India was imperilled by ignorant or seditious machinations.

The vote of thanks was carried unanimously.

Mr. J. F. Hewitt, in reply, said his paper was confined entirely to dealing with early times of village communities, but, had time permitted, he should have been glad to have described the Kolarian people with their light-hearted ways, and the patient Dravidians and Aryans. All he could say was that he had tried to trace the history of the country from his own personal observation, coupled with an exception of the earlier authorities, and he hoped he had given a fair account of what had taken place in early times, thus leaving it for other persons who wished to take the inquiry down to later times to do so. With regard to the remarks which had been made as to village communities as they now existed, he could only say that, through the greater part of India, village communities had been formed on Aryan models, and they now existed as they were handed down by the Aryans, who took the customs

which they found had existed before their arrival. As to what should be done in the future, that must be left entirely to the people themselves. We could not tell them to do this or do that; but we must train them to emulate the deeds of their forefathers. It was in this direction that his hopes for the future were founded.

Mr. Hewitt writes :—Time did not permit me, during the discussion on my paper, to answer all the objections and suggestions made by those who so kindly criticised it. It would require more than another paper of the same length to give the information asked for by Mr. Seton-Karr and Mr. Kimber, to carry down the history of Indian village communities to the present day, and to trace their progress in other directions than those of their internal constitution and organisation, which was all I could deal with in the limits of the paper I read. I should, however, wish in the present note to clear up a few misapprehensions which appeared from some of the remarks made to exist, as to the positions I wished to maintain. I did not by any means intend to insist positively that the village system came from the south, or that it was developed everywhere in the historical order stated in my paper. As Mr. Gomme correctly observed, a great deal in historical deductions of this kind must be ascribed not only to racial influences but to physical necessity. There is, I think, a very strong probability that the Kolarian village is the original type from which Indian villages descend, but the intervening links between the forest clearings, made by the early Malayan immigrants from the East, in which the soil was tilled by digging, and the more developed type in which it was ploughed, are very difficult to trace. The fresh tribes of the Kolarian race could not have brought cattle with them in their progress through the primæval forests. The tigers would have imposed a stern but emphatic veto on this proceeding. But if they did not bring them, how did ploughing and farming with the help of cattle originate? Was it through the Dravidians, or some intervening race? The problem is very difficult, but though I do not believe it to be insoluble, I am not prepared to give an answer at present. As for the progress of the village after it was taken in hand by the Dravidians, I have no doubt whatever that everywhere in India the order of progression was Dravidians first, Aryans afterwards. The evidence in favour of this conclusion is overwhelming and irresistible, and greatly exceeds that given in my paper. With regard to the remarks made upon snake worship, I would observe that the worship of the snake was entirely a Dravidian rite, and was only introduced into the Aryan worship in the days of its decadence. There were, in early times, after people's minds began to rise above fetishness and totemism, two great generalisations made by those races who tried to reason out the causes which produced the phenomena they saw around them. The races who liked the ground, and formed settled communities, held that the earth by its own internal generative power produced the products of the earth and all the beings living on it, and the snake and the tree were worshipped by them as the symbols of this productive force. The pastoral tribes, on the other hand, held that it was the sun and the heavenly powers which created and preserved all things, it was these powers they worshipped, and not the earth-born gods of the agricultural race. It was the amalgamation of these two systems with those of the totemistic tribal gods which produced the pantheon of the present popular Hindoo religion.

NINETEENTH ORDINARY MEETING.

Wednesday, May 4th, 1887; The Right Hon. Sir Thomas Dyke Acland, Bart., in the chair.

The following candidates were proposed for election as members of the Society :—

Adamson, Robert Lawrence, 7, Balfour-road, Highbury New-park, N.
Beaumont, Robert, The Yorkshire College, Leeds.
Gillman, Alexander William, Chalmers, Park-hill-road, Croydon, Surrey.
Kibble, John Baxter, 89, Upper Thames-street, E.C

The following candidates were balloted for and duly elected members of the Society.

Brearley, Benjamin J., Union Plate-Glass Works, St. Helen's, Lancashire.
Common, John Freeland Fergus, The Cedars, Llandaff-road, Cardiff.
Ellis, Herbert Owen, Forest-rise, Walthamstow, Essex.
Foster, Clement Le Neve, D.Sc., Llandudno, North Wales.
Hardwicke, William Wright, Stour House, Dovercourt, Essex.
Lubbock, Nevile, 16, Leadenhall-street, E.C.
Mooney, John, 14, Lansdowne-road, Didsbury, Manchester.
North, William, 28, Regent's-park-road, N.W.
Salamon, A. Gordon, 1, Fenchurch-avenue, E.C.
Simmons, George, Chertsey, Surrey.
Stokes, Frank, 49, Upper Baker-street, N.W.

The Chairman said—Mr. Morton needs no introduction to this meeting; I rather stand in need of being introduced by him. But, in compliance with his wish, I will venture to say a very few words, as a landowner deeply interested in the subject of his paper. First, I wish to express my gratitude to the Society of Arts for the interest it has shown in agriculture, and the work it has done for general education, especially for what it has done to promote a connection between industrial

art, and scientific and literary training. I must, for myself, say that I feel it to be a great honour to be invited to preside, and to stand where, thirty years ago, that good and great man, the Prince Consort, stood, when the author of "Chronicles of a Clay Farm," the accomplished Mr. Wren Hoskyns, delivered an interesting lecture on agriculture. I beg leave to be allowed to make one more reference of a personal nature. About thirty years ago, also, the Royal Agricultural Society met at Chester; the principal speech at a vast meeting in the great hall of that city was delivered by the great statesman and orator whose landed property is near the city. The substance of that speech has a most distinct bearing on the lecture of Mr. Morton. Mr. Gladstone said that agriculture began in the Garden of Eden, and would endure to the crack of doom. He then, with marvellously comprehensive grasp, described the long list of sciences which minister to the ideal art of agriculture, starting from the most inert mineral matter, describing the sciences which deal with mechanical, physical, and vital forces, and also those economic sciences which govern production and distribution. He said no human brain could grasp even the elements of all these sciences and their practical application. What then must the farmer do; he must come to the Royal Agricultural Society for information as to the results of science in its many bearings on the food of the people. Now, Mr. Morton has devoted a long, industrious, unselfish life to help the landowner and land cultivator to acquire this information, to turn it to account. We now have many professors who, by lectures, and text-books, and examinations, profess to feed the mind of the farmer, and to help them to feed the bodies of their countrymen, Mr. Morton will to-night, I believe, hit the right nail on the head, and all those who will listen or read what is the primary condition of agricultural progress at the present time. If I may sum up in two words, his aim is to give us not merely mechanical but dynamical force in the great struggle in which we are engaged.

The paper read was—

AGRICULTURAL EDUCATION.

By J. C. Morton.

The paper which I am about to read has been announced as on agricultural education, but might better be termed "Schooling before Farming;" that is more properly my subject. No great mistake, however, has been made, because the whole business of the hour, so far as I am concerned, will be to insist upon it that the preliminary schooling is by far the most important part of an agricultural or any other education. I do not know what you will think—looking at the great spread of trade newspapers on the wall behind me, what schooling before farming can have to do with that—what the comparison or the contrast of agricultural with other occupations in the matter of trade and business energy which is there displayed has got to do with the schooling before farming; or, if I could have represented the scientific and properly technical side of an agricultural education by a similar series of publications, so that the force brought to bear on instruction in the sciences of agriculture could be contrasted with that which is brought to bear on scientific education for the manufacturer, the engineer, or the architect, what would that have to do with mere schooling. We must not forget, however, that the influence of the preliminary school education is seen in the whole style of the future life, whatever occupation the boy may ultimately follow. The sound preliminary education for which I am to argue, is not only the foundation-stone of a future building—it is the seed of a future life, with influence and guidance in it, as well as mere security and strength. And the agriculturist, whatever the distinctive features of his occupation may be, will, I believe, quite as much as any other busy man, benefit by an education which may open his eyes a little wider than they are at present to matters which really concern himself, though they may seem to him outside the limits of his day's work. This I shall try to illustrate in all the three divisions under which his own, like every other occupation, lies. I mean his knowledge, his skill, and his industry. We have got into the habit of referring to these as the science, the practice, and the business of farming. I think simpler and better words may be used, and I shall refer, therefore, first to the truth, then to the art, and, lastly, to the trade of agriculture.

I.—The Truth of Agriculture.

Practical men are apt to kick at what they imagine to be an assumption of superiority by the man of science. They know or believe that, however skilful he may be in the laboratory, however conclusive his argument in the lecture-room, set him to manage a farm, and he will make a mess of it. Science is apt to present itself as a thing apart. It is always critical, and they meet it by being hostile. I overheard two farmers, strangers to me, in the railway carriage on my way to the Newcastle meeting of the Royal Agricultural Society in 1846, speaking on this very subject. They mentioned my father's name, and of course, I pricked up my ears. He had some time before started what was called an example farm in Gloucester-

shire. "Ah," said one, "he's sure to have made a lot of money." "Not he," was the reply, "a chemical head always means an empty pocket." And that represents a very common attitude of mind on the part of the practical farmer—yes, and of the land agent too—towards that which, of all the sciences, has most right to be called the science of agriculture.

And it will be no running away from my subject, which is the sufficient education of the boy intended to be a farmer, if I start with an illustration of it in the ultimate attitude thus represented of the grown-up man—of the experienced farmer, in short, as I will sketch him, or as he shall sketch himself—practical and successful, knowing thoroughly every detail of the business in which he has been brought up, and practising it all with the industry and thrift which are essential to success; the very ideal farmer for the land owner and the land agent, as well as for his brother farmers.

Let it, however, be understood that the quoted conversation by which I shall endeavour to represent his opinion is not coming, or likely to have come, from the mouth of anyone here present—nor from any mouth, I will add, that is in the habit of speaking at farmers' clubs, or meetings of chambers of agriculture, or of agricultural societies. It is not the five in every hundred farmers who study agricultural books, read agricultural journals, and attend agricultural meetings, for the purpose of giving or receiving instruction, that I shall represent. It is one of the ninety-five in every hundred—worthy and laborious men, who believe that they have no time for anything but thrift and work, or, if they have, prefer their recreation in another form—that shall be my spokesman. And he for once, we will suppose, has been present at one of these meetings, where others do the speaking.

The Parson and the Squire together have concluded that an evening's science class would be a good thing in the parish; and on one of the first autumn evenings, after harvest, you have gone down on their invitation—a young lecturer crammed with all that South Kensington can teach you—to give a preliminary discourse; and, on their invitation also, a number of the neighbouring farmers have come out to hear you. One of the audience, meeting you next day, will take you by the button, only just across the road, and bid you look over the hedge at the cottage garden on the other side.

"Look at that bit of land," he will say—the following, at all events, is what his speech will amount to:—"See how well it has been tilled. The soil has been opened, as you said last night, to the influence of air and weather. The land—dug deep below the surface—has made accessible to the roots of plants, stores of food which exist unused, as you assured us, in unmoved subsoils. Spade and fork and hoe—a carefully collected dung heap too—have made that little bit of land as able to resist disaster, as able to use and utilise whatever happens naturally, whether through drought or downfall, as if the most scientific cultivator had had the management. Look at that plot of potatoes, which has ripened kindly, with ample haulm to have fed a good crop below. See that bed of onions—bulbs uniform in size and place, equi-distant on the surface, and prospering on stores beneath it; that bed of carrots, too, or parsnips, feeding on the under as well as on the upper soil; that row of kidney-beans, not yet cut down by the frost, still vigorous in the air and sun, which has been enabled by the latter to feed prosperously on the former. You see, I was a listener to what you said last night, and I have picked up some of your phrases. That garden is just full of produce and of profit; and there is not a plant to be seen other than the tenant meant should grow, not a weed to rob the soil or displace a better sort." And then he will turn and ask, "Do you think, young man, you can teach me to do my land or cultivate my field crops better than that?" Next he will take you down to the pig-stye. "Do you think you can teach me how to manage my fatting stock better than this cottager has managed his? See how sleek and comfortable it lies in its dry lair—cleanliness and warmth attended to—sufficiency of all things without waste—every little economy whether of space, of litter, or of food constantly and anxiously directed. Do you think I can be taught how to do better than that? Can you, with all your learning, all your talk of 'nitrogenous' and 'non-nitrogenous'—all your scientific explanation, 'organic,' 'inorganic,' all the rest of it—can you put me in the way of improving on that mere labourer's management"? He is evidently getting angry. "Not you," he will exclaim: and then he will shout at you, "Why, that fellow can't read! Pooh! so much for all your science."

Is this a caricature? Gentlemen, I am not sketching any of you; and, if you please, I will at once say that the whole body of large farmers,

men of 500 acres and upwards, are excluded altogether from this review. They educate their families as other wealthy families are educated, and I don't suppose that they consider that any of their sons, if he is to be a farmer, needs less education than his brothers. But excluding these, we exclude only 5,000 of the 160,000 farmers holding 50 acres and upwards in this country. Excluding even all the tenants of over 300 acres, there are still 140,000 left, to many of whom my remarks may be applicable. I know men, indeed, holding more than 1,000 acres each, who will say that the man you may think I have caricatured is in the right; and every one of us knows men among his neighbours whom the picture fits. We constantly hear the story told with glee of successful men who can barely read and write, and of men of general intelligence who lose money at their business, as if the ignorance on the one side were the source of their success, and as if it were the intelligence of the other which had ruined them. "The best men I know—that is the men who have stood the recent agricultural depression best," says a clergyman of my acquaintance, "never trouble themselves with periodicals, or books, or journals." And even in the Council-room of the Royal Agricultural Society of England one has heard it said that it is possible to have "too much science." Perhaps if the word "truth" had been used as often as the word "science" hitherto, the prejudice would not have grown which is now so commonly expressed. However easy it might be to laugh at science, it would be hard for anyone to inveigh against a knowledge of the truth. And yet, of course, it is the truth that is the sole aim and end of scientific investigation.

Gentlemen, my contention is that a better and a longer school education than is generally given is desirable for the future farmer, in order that he may have the capability of trust implanted early—confidence in the existence of useful truth connected with his business—underlying it, in fact—which the mere labourer and drudge is apt to laugh to scorn. And what good would all that do us, it may, perhaps, be asked. Well, it would, at any rate, to some extent hinder men from making themselves ridiculous. And surely that deserves consideration at times, continually recurring, when due weight is sought and claimed for the voice of the agriculturist of the country; and are there no instances when this disbelief in so-called science has had this very effect?

Take an example. What about the malt tax? We have at length got rid of it; not, after all, as things have turned out, an unmixed benefit; but what an outcry was there not for years, at the injustice of restricting the British meat producer from the employment of the best raw material which in that particular manufacture he could use. An elaborate investigation by skilled experimenters had proved that malting is a waste of food, and proved also that not only is there a certain destruction of nutritive matter in the process, but that the remainder is not so feeding or so fattening as the barley from which it had been made. But this was not believed; it was a mere theory of the man of science. Not only was it not believed; it was incredible. The faculty of belief in any laboratory result did not exist. People could believe the wild talk upon the hustings of the party politician, who, first on one side and then on the other, sought the vote of the £50 tenant-at-will. They could not believe the truth which comes of a balance weighing to the hundredth part of a grain, or which comes of a mind—a man trained to the strictest accuracy of investigation—a man of science, a mere theorist they would call him, who was not a practical farmer. The £50 tenant-at-will—before all things a practical man—had been at school long enough, indeed, to learn to read, but not long enough to acquire the habit or the love of reading. He never looked at an agricultural journal, still less at a scientific memoir. He has got the power now of malting his barley for the feeding house, but he finds it don't answer. Mr. Randell, of Evesham, tells me knows no farmer who malts his barley for the feeding house. Mr. North, of South Thoresby, Alford, who farms 1,300 acres in East Lincolnshire, writes to me:—"I am not cognisant of a single instance in which malt has been used for either sheep or cattle." The malt tax, he says, was a sentimental grievance; its repeal has inflicted very serious injury upon the barley growers of his neighbourhood—at least 20s. an acre—and the benefit is absolutely *nil*. The truth about the value of malt as food now known is acted on; it might have been known forty years ago, but then it was not truth; it was what men called science—theory, and therefore unpractical, ridiculous. And may there not be truth known to men of science which is still mere theory, unpractical, ridiculous, from which we might have useful guidance now, only none of those to whom I am now referring ever think that help is possible from that quarter?

Sir John Lawes has told us that he writes twice as much in the American as he does in the English agricultural papers, because there he knows that he is read, and here he knows that he has virtually no audience whatever. The truth, the inner truth, the underlying truth of what happens on the farm, which has been learned, investigated, mastered at Rothamsted, the battle field of many an agricultural difficulty, conquered by our great scientific chief—all this stimulates to effort there. It is ignored by the great mass of English farmers, the 95 per cent. to whom I have referred.

A Definition of Education.—Let it not be imagined, however, that my argument for a preliminary schooling, up till at least sixteen years of age, is meant as a justification of agricultural education such as many a learned professor would define it. Professor Wrightson says, "A perfect agricultural education should include geology, biology, engineering and mechanics, drawing and architecture, chemistry, rural and political economy, commercial knowledge and book-keeping, law, and meteorology." However desirable all this may be for a future professor, the young farmer certainly does not need it all. I do not think, indeed, it would be a good thing to take him out of his father's guidance. There is an immense advantage in homely accustomedness to all the details of life upon the farm. All I want is that the father should not be the merely successful man who chaffed the lecturer from South Kensington in the village street just now. The father, in whose hands the boy grows up to his business, should believe in the value of all these branches of knowledge, though he will never master them himself; and the son, who will, no doubt, be entered soon enough upon the farm, should never hear outside truth of any kind disparaged or despised. The value of all these studies should be cordially admitted, not because here and there, and now and then, a practical wrinkle of service in the field or in the feeding-house is picked up, but because it enlarges and strengthens the whole nature of man. It is the idea that a man can have too much science that should be the really ridiculous thing; and for the rest, he should enter on his life's work not only early enough to acquire the habit of doing it, but confident that he has much knowledge to acquire, as well as much skill to win. Happily, it is not always that deficient schooling does leave a man so faithless and incredulous on these subjects as the ideal practical farmer I have sketched. I have a letter from a Dorset farmer who laments his ignorance. "I was taken from school," he says, "hardly beyond the fourth standard, as it now exists. I could read and write, and that was about all. I came home to work upon the farm in my fourteenth year, and every practice of the oldest style was always carried out—well carried out, no doubt." He had visitors, however, now and then, who had studied things, and knew the science, shall I call it? No, simply knew, I will say, the grasses separately, the nutritive value of each, the needs of different plants and soils, the fitness of many an exceptional crop to the circumstances of the farm. It is to secure the welcome which such men should have, to rebuke the ridicule with which their suggestions are often received, that is the main reason why boys should not be taken from school at the fourth standard, as aforesaid. If the instinct for learning, and the belief in outside truth and inner truth, and underlying truth has been implanted, it would not so much matter remaining long at school. In the case of the Dorset farmer, somehow, all this was implanted, and he was tolerably safe. He was sure to read and learn, not merely drudge and grind at his day's work, and that is all that is essentially necessary. That something more is desirable and possible is plain from the experience of many of our largest schools, where some attempt at teaching the elements of physical science are already made, as I shall report in the sequel.

II.—The Art of Agriculture.

Leaving now, however, the truth which underlies the work of the farmer, let us look at his technical fitness for his work—the art of agriculture, as I have called it. This, of course, like every other art, must be taught by apprenticeship, and the sooner that a boy can be entered to it, with due regard to other even higher interests, the better.

I am not going to speak of the necessity of this apprenticeship. The necessity of apprenticeship goes without saying. A man *must* have the skill which every art requires if he is to win his way. Nor when I come to speak of the business or the trade of farming, shall I think it necessary to speak of the importance of industry and thrift. All this, which is the result of training, and, therefore, a necessary part of education for any art or occupation whatsoever, it is altogether unnecessary to enlarge upon. Of course, character, including industry, and honesty, and energy, is

essential to success, whatever be the line of life adopted. And in so far as these are the results of education, they may be "taken as read" in any lecture on the subject. I need not enlarge upon them here. My subject now is the need of a general preliminary education, with a view to success in the art, as well as with a view to interest in the truth, of agriculture. How will good schooling help the farmer here? It will undoubtedly help him directly as well as indirectly. Directly, as I shall be able to show a few minutes later on; indirectly, as I will show at once.

The Indirect Advantages of Education.—Indirectly, especially, I will say, in respect of the standing which it gives a man in the competition through which he has to win his way. And I do not now refer to the killing rivalry of foreign agricultural producers, which he cannot help. I refer to the home rivalry, which affects his relationship to the landowner on the one side, and the labourer on the other. And although a strong man is better than a weak one in whatever relation he may stand to others—a better landlord, and a better tenant, a better master and a better servant—and though there is nothing injurious to any of those with whom he has to do, in being himself capable and strong even to the length of independence, yet I am perfectly aware that an argument for the better education of the tenant-farmer—in order that it may enable him to hold his own, as an intending tenant, both against the owner of the land which he would hire, and against the labouring man who may one day supplant him—may be very doubtfully and even angrily received.

Who is this, it may be exclaimed, that is laying his unhallowed hands on the ark of that sacred covenant which declares the absolute oneness of interest among all the agricultural classes—landlords, tenants, labourers—which no one ever thinks of questioning, we have been assured, except for his own selfish purposes? The question is not an unreasonable one. I wonder what selfish end I can have in view. For more than forty years I have edited a weekly agricultural journal, having touch, therefore, all along the line, of the biggest industry in which Englishmen engage—touch which, considering its duration as well as its extent, may be pronounced unique—of the biggest capital sum, the biggest annual produce, the biggest weekly pay-sheet, clearing house, and universal providership than even Greater Britain knows. If merely selfish ends had been my aim, I must have been a greater dunce than even the least appreciative of my friends supposes me to be; the fact being that I am to-day doing four-fold the work, with ten-fold the enjoyment, for the very same pay as was given me forty years ago. Mind, I am making no complaint; so that is all right, and I cheerfully acknowledge that it is all that I am worth in the market.

Gentlemen, I am not going to boast unduly of my two-and-forty years; on the contrary, the outcry which now and then they make in my mind and memory makes me sometimes think I know what the prophet Elisha may have felt when the two-and-forty ribald children—in my case printers' devils, every one of them—shouted at him in the street; and, unfortunately for me, there are no benevolent she bears at my disposal to put an end to the ugly record! But this I will say, that for more than two-and-forty years I have held up in the *Agricultural Gazette* its little weekly bit of a mirror to matters agricultural—often dull enough, no doubt, but never stained—unwarped, achromatic, plain, reflecting faithfully, therefore, however incomplete, whatever may have fallen upon it from the world of agriculture during all these years; not only held it up, but carried it about so that place as well as time might be exhibited; so that anyone who chose might behold in it, as in a glass, the current agricultural history of all those years, its causes and their results, discoveries, inventions and events, new methods and new teachings, failures and successes, enthusiasms and disappointments, progress and prosperity — depression, adversity and disaster.

You must admit that I ought to be the ideal witness on the subject which is occupying us to-night; and I claim to be a very good one; and I am telling my story thus in order to make good my claim. And I give it for my opinion on a review of all these years—in the interest not of one class but, as I firmly believe, in the interest of all—that the best possible preliminary education is needed, not merely to make the boy stronger and more capable as a future farmer, but to fit him for something else as well if that should fail him; to make him a better man no doubt within his fields, which it will do—aye! but to enable him to leave them. Why should I, a young man, we will suppose, educated to the very top of those qualifications which the practical man deems all-important, be tied hopelessly to any failing occupation I have chosen, being fit for nothing else?—"Educated! I have been accustomed

to my farm from boyhood. I know every acre of it, every tool upon it; every beast and sheep I know from birth to the butcher's shop. I know the soil I work—the plants I grow, the animals I breed and feed and fatten—the management in detail of every one. I can plough and sow, and reap and thresh; I can manage the ewe flock, the cow-house, the stable, and the pigstye. I can give a drench to a sick beast, and I can see when it wants one. I can wheedle a customer in the market-place, and I can slang him if he needs it. I am a practical man from head to foot. I never read an agricultural journal. Do you think I want the *Agricultural Gazette* to help me to go into that twenty-acre field and put things straight? I don't want nobody to teach me."

Again I ask, is this a caricature? "Caricature!"—he will himself exclaim—"I am the very ideal tenant of four-fifths of the landowners of this country, and of more than nine-tenths of all its land-agents." I think, gentlemen, that my picture is a caricature, nevertheless, to some extent; and I put that bit of bad grammar into our friend's mouth at the last, in order that you might think so, too. I do not believe that the exclusively practical man, as I have sketched him, is altogether the ideal tenant of any thoughtful man. I yield to no one in the belief that thorough practical accustomedness to everything on the farm is essential to the success of the farmer; but certainly an attitude of contempt for everything outside does not help him, either directly or indirectly. The owner of the land, equally with the tenant, will find out that my practical friend, whom I have sketched, may perhaps weather a year or two of difficulty as patiently and well as anyone; but if the storm shall last, so that an altogether different course must be discovered, a very different sort of man is needed to lead the way to ultimate success. He is all right, as he declares himself, so long as the circumstances to which he has been accustomed, and which have made his practice and himself, remain unchanged. When things alter—John Bull no longer depending on him for his food, foreign supplies under-selling him—he is floored. He has no alternative, no belief in any alternative that may be offered. His own special remedy in difficulty—ploughing another furrow nearer the fence, putting more personal labour into it, screwing in every point—the only resource he has is insufficient. The tenant is ruined, and the landlord too—the tenant first. His pride in his exclusively practical education is certain to have a fall. If he could have seen an inch beyond his nose, he would have lamented the narrow limits of his small capacity—not only gloried in his perfectness within them.

"Why should I," he would have cried, "have had to go before the land agent or the owner all these years to make my bargain for the land with this tremendous handicap against me—I knowing, and he knowing, and I knowing that he knows, that I am fit for nothing else, and that I must come back to him. Yes, I can emigrate, and get a living, where, land being cheap and labour dear, I may realise my value; but that is not altogether the end that one desires; or I can, perhaps—being, as I have supposed, a good market man as well as a good farm labourer—I may go to swell the army of middle men who swarm now beyond the needs of either consumer or producer."

But this, it may be said, is a picture of the past. The practical farmer, whether fit for anything else or not, is at any rate independent enough now in his dealings with the landlord or the agent; he can make his bargain now almost as he pleases.

But what about the future? If the picture I have drawn, once true, no longer represents his relations to the owner of the land, what about the coming growing competition which he has now to meet with the labourer, who will more and more compete with him for the occupation of it? What about the indirect advantage of a good education here? His success, of course, depends (1) to some extent on being sharp and resolute, and strong of will. But these are natural gifts which are common to all classes alike: and "your labourers," he may be told, "are at least twice or thrice as many as you; and if natural ability, quickness, and keen look-out, are to win the day, the odds are two or three to one against you in the coming contest. You will probably meet even more than your match in the matter of mere natural ability. Then (2) he will say his success depends more on hard work and thrift than on any single thing that he can name. But "your labourer," he may again be told, "has known all these for years; he has been accustomed to live harder and work harder all his life than you. There is no hope for you on this score whatever. He is certain to be your superior there, and your dependence on this for the maintenance of your superiority is dependence on a broken

reed." Again, however, he will say that (3) farm capital is required, and that in this he has an immense advantage in the competition. And here he tells the truth; but even here he cannot speak with perfect confidence. He has been losing capital year by year for years; there is more borrowed capital in land-holding —and I may add in land-owning, too, to-day —than probably there ever was. And I incline to think that a labouring man, who is gradually and laboriously improving his position, is a safer man to lend to than a small farmer who is gradually, but surely, losing his position. And have you ever thought of what the statistics of farm holdings have to say on this subject? Besides the mere allotment holders, and besides 12,593 holders of cow plots in Great Britain, there are 135,736 holders of land under five acres each. There are 148,806 holders between five and twenty acres, 84,649 up to fifty acres, 64,715 up to 100 acres, 75,573 up to 300 acres; only 13,875 up to 500, 4,826 up to 1,000, 602 over 1,000. Any man who has prospered on five acres can take twenty, any one prospering on fifty will be glad to take 100. There is nowhere a step on this ladder which any one who is really climbing cannot take, however low he may have begun. And I say, therefore, that even your superiority in respect of capital does not necessarily save you. Last of all (4) I suppose that there is no tenant farmer whatever but must admit that there is some advantage to him in that he has been better educated. No one will deny that a good education is of some service, even in the art of agriculture. Ah! but that advantage, again, also, he is losing, and he may again be told, "Your labourer is being educated a lot better than he used to be; yes, and at your expense." I will even say the labourer is being better grounded than the farmer's son; and, after all, the education which I am contending for is but a grounding at the best. Here is a report from the north of England. "The middle-class tenant farmers," says my correspondent, "send their sons to the nearest available private adventure school. When intended for a commercial life, they are probably kept at school until sixteen or seventeen years old. When they are to go on the farm, they are usually taken from school at fourteen, as the general belief is that to run a lad longer only begets habits of idleness and extravagance that last through life. The great blot in the education of most of our farmers' sons is that they are so irregular at school. Any pretence is good enough for a holiday, hay time or harvest, an extra spurt in carrying manure, a pig-killing, an agricultural show, sheep-washing, or sheep-shearing. A farmer's son, an intelligent lad, and my eldest son" (the writer lives in a small town in the north of England, and probably would consider himself of the same rank as this middle-class farmer), went to the same school, and at the age of fourteen they went to the same office. After a few weeks' trial, the farmer's son was sent home, with a recommendation that he should go to school for another year or so, and he made a start, but he was so ashamed to appear before his former schoolfellows, that he elected to go on his father's farm. He had plenty of ability, but his irregular attendance had told against them. In the case of the labourers' children, the School Board officers compel regular attendance; but in the case of the farmers' sons, paying upwards of ninepence per week, the officers have no control over them." Thus, besides industry and thrift, which the labourer has even more than the young farmer, he has a better grounding at the school. The Board schools of the country are better than the adventure schools for teaching and implanting the elements.

It is not a difficult ladder which even mere labourers have to climb; they are inured to the hard labour and the thrift by which this task will be accomplished: and they are being well educated. On the score of mere natural ability, the select men of the larger number are in all probability better gifted than the select men of the smaller number; and whether the latter shall not be beaten in the long run by the former, depends mainly, I contend, on this one condition of the better education which, if so disposed, they can still command.

The Direct Advantages of Education.—And what of the direct advantages of this better schooling?—the direct advantages of this better schooling before farming could be illustrated by both argument and example. Let the result of this education be put to waken up the faculties to the existence, serviceableness, and interest of much truth that lies outside the daily work of life—surely that must be valuable. A man who has but an inkling—the appreciation which good schooling gives him—of the outside truth lying open to the reader, is certainly in the way of learning what is practically useful. Is so-called book farming wholly trash? Are there no men who know among the writers who have filled our agricultural libraries, and who now fill the

pages of our agricultural journals? Surely there are new suggestions continually coming up, new practices rising, new information by which A, B, and C are prospering, which might be made available for all the other letters of the alphabet. Gentlemen, this really is the subject of my paper, and I ought to defend this point at length. I prefer, however, in the short time that is left, to prove it less by argument than by example. Nearly thirty years ago I met a young man in a Great Western third-class carriage, who was reading Lavergne's recently-published book on "English Agriculture." I found that he was a bailiff on an estate near Faringdon, in Berkshire. I afterwards saw him there, and I have corresponded with him ever since, and a letter from him received the other day tells me that his start in life was as bailiff, at the age of twenty-two, on the home farm of the nobleman over whose extensive and valuable estates in Yorkshire he is now chief agent. He attributes his success to his determination to acquire a practical knowledge of everything he has had to do with. Whether with crops or cattle, or houses to shelter them, he says, "I have always been master of the situation." No doubt he is right in this; no one will more strongly argue than myself for the absolute necessity of this practical knowledge. But whenever I think admiringly of his continual success, it is the young man who was studying Lavergne in the outset that I remember. Again, forty years ago I heard of what was called the Dick Bequest in Aberdeenshire, which provides funds for large annual prizes, won on examination by the parish schoolmasters of that county; and I was told that this very considerable increase of attainable income had attracted the best men in that profession to the Aberdeenshire schools. "You will accordingly find," said my informant, "that the boys are better educated, and that the most capable Scotch bailiffs in the country have been educated in these schools." One of the last whom I employed was an Aberdeenshire man, whom I soon learned to value; and he has been valued still more highly since he left me. His career, a continual success, has been largely due to his schooling before farming. He is now "a very warm man indeed," I was lately told by one of our leading seedsmen, with that solemnity of demeanour which becomes a speaker when the warmth to which he refers means wealth, "He must be a £6,000 or £7,000 man at least," I was very seriously informed. His constant progress through the art of agriculture has been largely owing to efficient schooling before farming. And now, gentlemen, if you are looking for the end of my harangue, and for the solution of the riddle on the wall, you may be glad to know that, in another sense, you are "getting warm." My last point relates to the influence of good schooling on the trade of agriculture.

One word more, however, before I leave the uses of good schooling to the future farmer in the prosecution of his art. The whole subject of technical education comes, of course, under this chapter. If by technical education the acquirement of skill by practice is meant, then it is technical education, and technical education alone, which the farmer now receives; but if scientific training and instruction be included, then I say that good schooling will do more than anything else to make ready and willing to be taught a people prepared to receive it. I must add yet further, among the mass of correspondence out of which this paper has arisen, there is not a stronger or a better letter than one that I have received from a Banffshire correspondent, who had been applied to for information about the Dick Bequest, to which I have referred. He laments the displacement of the crofters—the small-farm population of his county. There the farmer and his family worked together, strove together, prospered together, suffered together. The young man grew up in the midst of his future work, with the habitual touch of calf and beast, and cow, and horse, and sheep, and seed, and soil, from very infancy; he grew up with little knowledge of general literature, but he was thoroughly well taught, nevertheless. Obedience to parents was the central law of the household, and godly training in the precepts of the Bible, read every day, and in the precepts and principles of the Shorter Catechism, learned every week, produced as its result a grave industrious self-respecting race. "All this," he says, "has gone. The large farm has swamped everything. The men now live in kitchens or in bothies, and their families in villages. The father does not see them once a week, and the children, thronging to village schools, are growing up reckless of all home control; and good schooling (Dick Bequest or not) is a poor substitute." The character of the people, he says, is going, or has gone—and the early accustomedness to farming and farm-work has disappeared. If my correspondent should ever see this paper, he will

see, I doubt not, much that he cannot sympathise with. On the other hand, I—having read his letter—accept its every protest and anxiety with all my heart. No one shall ever accuse me of disparaging, or even of putting in a second place, that for which he contends. Neither of us, I fear, can help the tendency to the aggregation of small holdings in prosperous times. There is, however, nothing in the argument for good schooling, even in reference to the art of agriculture, which disputes—still less denies—the absolute necessity of character as the foundation of success, and the immense advantage of early training in the field. We turn now, however, to—

III.—The Trade of Agriculture.

And here, supposing myself to be addressing any of the 80 or 90 per cent. to whom I have been referring, I would say, "You already acknowledge the need of prolonged schooling for a commercial life; you give your boy intended for trade a longer school time than the one intended for the farm. Well, here is the biggest trade and commerce in the world. Over 70,000,000 of acres, worth 2,000,000,000 of pounds, are concerned in it, and two or three hundreds of millions of capital are employed. The sleeping partners in this great business are tens of thousands, and the active partners hundreds of thousands. On the life, and enterprise, and energy, and capability with which it is conducted depends the prosperity of millions. There is no trade, manufacture, commerce—great as England is in all of these—that approaches this. Nor is there any other whose apprentices receive less of a general and preliminary education before they start. And if other trades and businesses are better managed, what wonder, considering the better training they receive—being known to need it. Has anyone here ever overheard the conversation of a company of dealers at a wayside station when waiting for their train after a day at the neighbouring fair? The final sale of a horse to the man who wanted it—and gave a long price, too—was four or five steps off the original purchase from the breeder who had brought him to the fair for sale. "A," "B," and "C" each had had it in the course of the day, selling his bargain one to the other in succession for a £5 note or less, until at length the £60 was reached for which it taken home—the original owner having received but £40. It is a picture of trade experience in agriculture all through. I should think that agriculture, as a trade, is the biggest muddle in the world. No doubt a business which turns its capital only once a year will never be so urgent or so sharp as others are whose capital is turned over six to twelve times annually; but there is no excuse for the listlessness which, to a large extent, exists in the trade of agriculture. As long as I remember, the cheese was always sold for whatever the broker or cheese-factor chose to give. I asked, the other day, one as old as myself on this very point. "Oh!" was the reply, "we never knew what the price was to be till the cheese was in the warehouse of the factor." And, to a surprising extent, this is still the case. I was judge of dairy farms—one of three—at the Preston meeting of the Royal Agricultural Society. The best floor of cheese we saw, good in every month and on every visit, had not made anything like the price that had been obtained elsewhere. The farmer, easy-going man, had taken what the factor chose to give. And this is true in other special sections of our business also. Hops, as a rule, are consigned to factors, brokers, or commission-men, who sell them to hop merchants, and these again to the brewers. And whatever easy-going listlessness there may be in the outset on the one hand, they are sharp enough on the other in every succeeding stage. The scale of commission is high. Factors often advance money to their clients, the hop planters, and in some cases the crop is mortgaged to its full value before it is picked. Sometimes it does not realise the amount of the advance, and the balance is carried over until the next crop, interest, of course, strictly charged. The planter is thus very often placed in the factor's power, and it is alleged that the latter plays into the hands of the merchants, who are an exceedingly small body, having a practical monopoly of the market, which they "bear" and "bull" as they please. "It is an abominable system," says an unquestionable authority, "opening the door to a deal of suspicion, to say the least."

So much for cheese and hops — two specialities. How is it with the ordinary produce of the farm? Time was when a man went to market himself, whether to buy or sell, and fought the bargain out, with great waste, no doubt, of time and temper, but with a distinct effect upon the sharpness and judgment of the farmer. Now the whole thing is swept away at auctions, and a very fishy business it often seems to be. And every now and then we get indignant over the enormous

differences in price in the experience of the producer and the consumer; and one and another undertakes to supply the meat market with carcases home-butchered, and he tells the story of the profits which he makes in the columns of the *Times*. The evil will to some extent, no doubt, correct itself, and men already band together to make purchases at wholesale rates; and co-operative associations, thus helping to provide cheap raw material, are also trying to carrying out the sale of the manufactured article on terms less ruinous to the manufacturer.

One of the latest efforts of the active mind whom we have just lost in the agricultural world was directed to this end. The late Mr. Henry Jenkins, secretary of the Royal Agricultural Society of England, when nearly thirty years of age, well-trained and well-educated, stepped, an utter stranger, into the agricultural from the scientific world; and during eighteen years he did more to waken up English agriculturists, and to put English farmers in the way of earning a better living, than any one—I might say almost any ten—of those who have been born and bred within the four corners of the farm. He could see that the trade of agriculture specially needed reformation; and his last lecture before the London Farmers' Club was addressed directly to this one point—the possibility of organising co-operation for the work of both sale and purchase. And I can hardly doubt that if discussion shall follow my long story now, it will be directed very much to the possibility of a help for agricultural distress in this department; and to the importance of a commercial education for the farmer on this account.

My object here is to simply quote the farmer's own verdict against himself, to insist upon it that the young farmer, as a tradesman, needs a better commercial education than at present he receives. Certainly, it is impossible to shut the eyes to the enormous differences which exist between agriculture and other occupations in respect of the brisk trade energy of these, with which it stands in woeful contrast. Probably the extraordinary variety of weights and measures known to English agriculturists, and the protest which the market man almost invariably makes against any extension of the use of weighing machines, ought also to be quoted in illustration of the trade muddle which I am charging upon English agriculture. I have sketched this contrast between trade and agriculture in respect of energy and promptitude often enough before, and must not repeat myself. But the display on the wall is an illustration which must strike the eye. Here is agriculture, an industry employing, land and stock together, thousands of millions of capital, and here are other industries engaged in manufactures, in construction, and in distribution, employing nothing like so much. What a contrast, is there not? Of those engaged in farming, not five per cent. ever take a farming paper. I inquired once as to the corresponding experience of the publishers of medical journals. Medical men are registered, and can be counted, and I could find that everyone took one, and that many must have taken more than one. They are an educated company, who believe in the constant growth of knowledge and of skill. The bedside experience of one doctor is studied by another; the clinical lectures representing hospital experience are read everywhere. Is there any of this in agricultural experience? And yet the farmer and the doctor have much in common; both have to do with life, and the success of both depends upon an educated eye, and on sharp and sympathetic insight. The one reads everything that offers an opportunity of further insight — any enlargement of experience—any inkling of improvement; to the other, book farming is a term of reproach. Look at this display upon the wall, where the few agricultural prints are compared with the multitude of journals devoted to Construction, Manufacture, Distribution, and the Person.

Here, representing the enormous agricultural interest, we have eight papers, and that is too many for the readers they command. In gardening there are nearly a dozen journals, eagerly studied, and largely circulated; and yet what is the garden to the farm? In manufactures, what a list! The farmer who grows the corn does not care to read about it (for it is the live stock that is the main interest to him), but the man who grinds it knows better. The miller here has made his weekly journal a most valuable property. Here also, are the *Textile Manufacturer*, the *Pottery Gazette*, the *Brewer's Gazette*, *Leather*, *Paper-making*, and many others.

In construction, the *Architect*, *Engineering*, *Builder*, *Iron*, *Timber*, the *Engineer*, are all important and successful weekly publications carried on with costly enterprise. The papers classed under the head of "Distribution" are an army. Every special industry has its organ. The list is one of the wonders of the country. Pleasure, of course, is amply

represented, and some of the papers I have collected here are useful also. Some of them, amid their yachting and their cricketing, horse racing, shooting and fishing, and their chess and card-playing, can, without disgusting their readers, even give a column or two to farming. In personal and domestic matters, every section has its weekly representative—*The Tailor* and *The Hatter*, and *The Glover* and the *Shoemaker*, and the *Dressmaker*, and the *Cook* and many others; and last of all, for he, too, has a periodical which represents his interest, *The Undertaker*. Each of these discusses the art to which it is especially devoted; and you may say that the contrast between their success and the comparative failure of agricultural journals lies rather in their relations to the art and to the truth than to the trade concerned. Not so. You must not think that any of these agricultural papers could live of their usefulness to the art or the truth of agriculture. It is their usefulness to the trade of farming that is their salvation; in so far, that is, as any of them can boast that they are safe at all. It is the market report that is all important; and it is their advertisement sheet that pays their way. The price of a weekly agricultural paper—and I believe that some men give even 5d. a week for their weekly agricultural journal—does not repay the expenditure on its production. None of these journals could live upon the thousands of pence or the hundreds of sixpences that thus come in. It is the advertisement columns and the outside trade energy—not the trade energy of the farmer, but the trade energy of those who would supply the farmer, which is thus illustrated—that saves them. And not without reason is it (finding, to my amusement the other day, that even the bill posters possess their organ) that I have put the *Bill Poster* in the place of honour, dominating the whole of the large series of trade journals here exhibited, the king of that community, whose portrait is presented to its readers, is really the emperor of the whole affair so far as the finance of trade literature is concerned.

Gentlemen, my paper has been an argument in the controversy which has gathered round my subject, rather than the contribution of any positive statement on the subject itself. This, however, has not been forgotten, and I have collected a quantity of information on those local and provincial schools which have special agricultural interest, and it may appear in the *Journal* of the Society if the Council approves. You may, perhaps, think that in my references to the subject of trade enterprise and trade literature I have run away from my subject altogether, but it is on "schooling" before farming that I would depend for agricultural improvement in the matter of trade organisation, enterprise, and energy, quite as much as for that most desirable warmer side towards the value of the truth of agriculture, and the higher position in the art of agriculture to which it will contribute. I have a number of personal memoirs by which I believe your attention could be retained for another hour, which entirely support my contention here. The best men in the world of agriculture, to-day, have been well-educated boys who have passed through the offices of lawyers or accountants on their way to the field. This it is—with the burden of responsibility early laid upon their shoulders—that has made them the men they are. "In my eighteenth year," says the very premier of Scotch farmers, "I was sent to a solicitor, in whose chambers I spent a year and a-half, where I gained some knowledge of affairs afterwards of use to me; but the special benefit was that I was under authority and had regular hours of daily work. The discipline of yielding prompt obedience to the orders of a superior, of confinement to one place, and of diligent daily employment within stated hours, if continued until these restraints cease to be irksome, is of far more importance than the nature of the occupation. There is little hope of a youth coming to much good as long as he 'can't be bothered' to do this or that. I thoroughly believe in the importance of his serving an apprenticeship so that it can be a real one." "I left school when I was sixteen," says a Yorkshire farmer, who now takes a leading part in every good thing in his own county. I would paraphrase his words—"I remained at school until I was sixteen, then going to work at once, and circumstances made me master six months afterwards. At eighteen I had my present farm of 400 acres; six years later other 600 acres fell in." "I left a London office at eighteen," says another leading agriculturist in a southern county, "and had to take the management of a tenantless farm, and blunder as I could into knowing how to work it." This he soon learned for himself, and he has since known how to teach others. Early responsibility on the top of good schooling, with some amount of trade guidance, has been the foundation of success.

One of the best practical farmers and

largest-hearted countrymen I know, also in a southern county—one of the 500 in this country who hold more than 1,000 acres—tells me he left school between sixteen and seventeen, where he had been trained less, he says, in classics and in mathematics, than in play hours in the workshop and the laboratory—that then he came home to the farm, where, from his father, and the bailiff, and the shepherd, he learned the practice of the farm—retaining his love of botanical and scientific study, still reading, he tells me, elementary works on chemistry, Morton on soils, and others books bearing on agricultural subjects.

I have, perhaps, wearied you with my argument for good school and good training—schooling which shall put him in cordial and confident relationship with truth from whatever source—which shall give him a better standing, in and after his apprenticeship to the art, and which shall quicken and inspirit him in the conduct of his business. Let me, however, add a word, before concluding, on the corresponding need for both the labourer and the landowner.

The labourer and land owner both want good "schooling" before farming. The former, it is Mr. Barham's contention, is getting a schooling now, which is taking him away from country work. In former days such schooling as he had was monotony and drudgery, and he looked forward to the time when he could escape to be a farmer's boy. That was then his goal. Now, his schooling opens his eyes to possibilities of which he never used to dream, and he is apt to look down on work upon the farm as inferior. It might remedy this tendency, Mr. Barham rightly thinks, if his schooling could give him the impression that there is more in farm life than mere drudgery; gave him an inkling of the enjoyments of the highest kind, which the truth as well as the art and trade of farming is capable of giving for the farmer.

And what is to be said of the corresponding awakening which the owner of the soil requires? The Royal Agricultural Society had undoubtedly done much to educate the farmer, and especially the land-owner, by its publications, and by its action generally, long before it had called to mind that the better education of those engaged in agriculture is one of the specific purposes for which it was incorporated by its Royal Charter. Since it has awakened to its duty in this respect, it has endeavoured to discharge that duty by annually offering prizes awarded by its own examiners to young men preparing for an agricultural life. These examinations were in the first instance directed simply to the improvement of the preliminary schooling. Latterly, they have been directed exclusively to the promotion of scientific training—stimulating education in the truth underlying the professional work of the farmer. Probably the latter is more in accordance with the requirements of the Charter, but it is the former after all which is the really essential thing; and I gladly quote Sir Thomas Acland, who was the strength of that movement in its earlier years, as having felt from the beginning that "schooling" before farming is the true foundation-stone of any sound agricultural training. There is no better statement anywhere of the subject which has occupied us to-night than was given by our present chairman in his address on science and art, in connection with agriculture and religion, at Barnstaple, in 1883, and published at that time in the local papers. The portrait of a perfect countryman in respect of character, ability, and intelligence, as the outcome of schooling and apprenticeship, is nowhere more accurately or more sympathetically given.

It is fortunate for this country that the owners, as well as the occupants of every countryside, equip themselves for the country life which they enjoy—get trained for the duties which belong to their position—serve an apprenticeship we may say, until its restraints, as the wise agriculturist whom I have already quoted says, become no longer irksome—until their labours and responsibilities become, indeed, to be the very joy of their career. One might speak of those present of whom this, and more than this, is true. They have been entered early in the career which has not only been a joy to themselves, but beneficent to others. If I may not speak of these, I may, at any rate, take an example from among lives which we have lost. I have been told of the late Mr. Henley, long member of Parliament for his county, that on his marriage he was placed by his father—there to learn all that as proprietor he ought to learn—on the 500-acre farm on which he spent the first twelve years of his married life. In a good farmhouse, with no such great addition to its accommodation as made it unfit for his successors, his family grew up—he himself acquiring that thorough practical touch everywhere of the Country, the Union, the Parish, and the Farm, which a landowner above all men needs. Here, without neglecting the duties of the position which was ultimately his—taking his share in

magisterial work—sharing also in the enjoyments of the field as well as in the duties of the estate—he became the thorough countryman he was: practical, homely, well-informed, in all that he undertook, growing in power and in sympathy with all sides of country life, so that no better man could be found to take the lead in it—no better to represent the county in Parliament—no better representative of true country interests in the councils of the Queen.

That country, gentlemen, is to be congratulated where husband and wife, in the highest as well as in the humbler ranks, find their true enjoyments in their duties; and there are none higher, socially, industrially, even intellectually, than those which belong to the truth, the art, and the trade of agriculture. But the power of appreciation depends, whether in the owner, or the labourer, on that preliminary training of all kinds which is included in the subject of my paper—Schooling before farming.

DISCUSSION.

Mr. William Botly said he had been for many years an advocate of agricultural schooling, and in the year 1869 read a paper on the subject at the meeting of the Royal Agricultural Society, at Exeter, when the present chairman, amongst others, took part in the discussion. Education at that time, and for many years afterwards, was not thought so much of as it was now, but, fortunately, great progress had been made since then, and they were much indebted to Mr. Morton for what he had done in the matter. He remembered on one occasion remarking that landowners required education as much as the farmer and the labourer, and that a farmer could not farm well unless he were secure in his tenure.

Rev. Dr. Bartrum (Berkhamstead) said England was under great disadvantages as compared with most other countries in the matter of agricultural and technical education. In Germany there were eighty schools where agriculture was systematically taught under Government inspection, whereas in England, though there were two colleges, the fees were so heavy that they were altogether out of the reach of the ordinary farmer. In Switzerland, also, there was systematic teaching of this subject. There was only one dairy school in England, which he believed was supported by private munificence; but it was a remarkable fact that at the dairy show at South Kensington one of the prize winners had received only six weeks' instruction in that particular school, showing the enormous advantage of receiving good technical instruction. Farmers, as a rule, were now quite unable to send their sons to boarding schools, and he suggested that technical schools should be formed in unions or counties, and maintained by the local authorities. Some short time ago he urged strongly that local authorities should have the power of establishing technical schools for teaching the subjects suitable to the locality, the whole of the area to which they belonged bearing a certain portion of the expense. To show the advantage of chemistry to farmers, he might mention that Mr. Smith, the lord of the Scilly Islands, who had land in the same parish as he lived in, told him that when he first went to Scilly, wishing to grow a particular crop, he consulted the late Dr. Voelcker, who analysed the soil and recommended him to employ a certain chemical manure. He did so, with perfect success; but one year having an unusual quantity of ordinary manure at command he thought he would use that instead, with the result that he did not get half his ordinary crop.

Mr. Manning said he had in his hands a letter from the late Mr. Jenkins, dated April 26th, 1886, in which he replied to a question he had asked him, viz., how he could account for the enormous rents paid round Paris, as quoted in Mr. Broderick's book on "English Land and Landowners." Mr. Jenkins confirmed the statement as to the extraordinary rents which were being paid, and said it was only possible on account of the industrial training of those who occupied the land. This was confirmed by Mr. Robinson in the *Garden* newspaper, and also in his book on the "Parks and Gardens of Paris." Another letter he wished to quote was from the late Prince Consort, under date of September, 20th, 1849, which was printed in Sir Theodore Martin's life of the Prince. In that letter he said, "the improvement of the condition of the working classes can be aimed at only in four ways;" the first of these was industrial training; and then he went on to mention also improvement of their dwellings, the granting of allotments, and savings' banks, and benefit societies, and the Prince showed that any real improvement must arise from the exertions of the people themselves. He wished to emphasise the importance of industrial training in rural schools, especially in one branch of agriculture, which was very much neglected, viz., fruit-growing. Without industrial training in the rural schools, the allotment system would be practically almost a failure, for it was quite impossible for the small cultivator to compete with the large market gardener.

Prof. Wrightson said that they knew a great many people were of the opinion that the farmer could exercise his functions and cultivate his farm to the best advantage without a scientific education, and having paid a good deal of attention to the subject for the last thirty years, he must say there was much truth in that idea. Many of the best farmers he knew, farming some of

them over 1,000 acres, were destitute of all knowledge of science, and one of the most successful farmers in Wiltshire only yesterday told him that he never read the Royal Agricultural Society's journals. The question then arose, what was technical education needed for? He believed a good farmer was himself the best teacher for his sons, and that apprenticeship was the right way of learning any business. But a time had now arrived when profits were made with great difficulty; even the best farmers could not make a profit except under exceptional circumstances, and the landowners themselves were confronted with a very serious difficulty. The tenant could give up his holding, and could perhaps take another upon terms which would allow him to make a living, but the landowners could not thus escape, and they were not instructed in agriculture. It was their sons, rather than the sons of farmers, for whom the colleges were intended; if they depended on farmers' sons neither college would have more than three or four students. The late Mr. Jenkins divided agricultural education into sections; first, the higher education of gentlemen and noblemen, and of those who were intended to manage large estates; second, was the education for farmers and bailiffs; and third, that of labourers. No attempt had yet been made to deal with the last two, though there was a fairly successful attempt to grapple with the first. He would ask if this technical agricultural education was to be good and thorough. If so, you could not frame a curriculum without embarking upon a highly complex scheme. You could not teach about soils without touching on geology, chemistry, and physics; and it was impossible to deal properly with the fattening process in animals without approaching physiology. He would appeal to any Board of Examination which had ever attempted to frame an examination on agricultural subjects, whether they were not bound to elaborate a very complicated scheme. In fact, the criticism of Mr. Jenkins on the Normal School at South Kensington, was that it was too elementary, and did not cover sufficient ground, and in the recommendations appended to his report, he added about a dozen other subjects. If the aim of the paper was only to show that a good education was necessary for a farmer, he should claim that for every man; and if Mr. Morton thought that, with a good education, a farmer, if unsuccessful, would be able to turn to some other occupation, he begged leave to differ from him. He did not think any man who had been engaged for some years in one profession could turn his skill and energy in another direction with any chance of success.

Mr. J. C. Rogers (Secretary of the Surveyors' Institution) thought the object of the paper had been a little misunderstood. The gist of it was practically contained in the sentence which said that a good schooling would do more than anything else to make a man "willing to be taught." The difficulty Mr. Morton had been pointing out was that the farmer had not sufficient education to understand his own deficiencies. He was not a practical agriculturist, but he had a general knowledge of the farmer, and should say that a more immovable being could scarcely be found on the face of the earth. The result of a more extensive system of primary education amongst farmers, especially one which should have a flavour in it of their future occupation, would be of undoubted benefit. Such a system as Professor Wrightson had referred to had already been foreshadowed in the Report to the Commissioners on Technical Education by Mr. Jenkins, and such a system would be possible, not by imposing additional rates on the already overburdened ratepayers, as one speaker seemed to suggest, but by utilising existing machinery, and making the parish schoolmasters to some extent teachers of elementary agriculture, chemistry, physics, and so on, and perhaps providing a higher training for those who showed unusual intelligence. It was not the custom in England to have a State department to teach every imaginable thing, they were accustomed to look rather to local institutions. Something had been said about land agents preferring the farmer who knew nothing of science. That might have been so in the past, but it was fast disappearing. Education was spreading rapidly amongst land agents. The Surveyors' Institution had established a system of examinations for land agents, and he believed that more candidates came up for that than for any other agricultural examination, and the number was on the increase. Although these were not times when the land agent could choose his tenant, being generally glad to keep a tenant, whatever he might be, the time would come when the land agent would select the tenant on account of his scientific knowledge, and the more ignorant would thus get gradually eliminated. He thought Mr. Morton by this paper had added to the large debt which the agricultural community already owed him.

Mr. Morton, in reply, said it was not his desire in any way either to disparage or praise scientific or technical education, but merely to prove that if a young man came to his business well educated, he was much more likely to appreciate any information he might obtain by attending lectures or reading books. He was glad that the criticisms made upon him would be reported and printed. At any rate he had been saved from the worst of all condemnation which had been unwittingly pronounced by Tennyson's "Northern Farmer," when he exclaimed of another preacher to whom he had been listening, "'a thowt 'a said what a owt to 'a said—and I coom'd awaay."

The Chairman, in proposing a vote of thanks to Mr. Morton, said the criticisms passed on the paper showed the great value of his work.

He had known Mr. Morton nearly half a century, and they both joined in reverencing that great teacher of English farmers and landowners, Philip Pusey. He was a profound scholar and philosopher, but, above all, was fully possessed with the spirit of English literature, and his great achievement was this, that he brought down abstract science from the clouds; he compelled Professor Way and others to be practical, and he lifted agricultural writing out of the mud into part of the noble literature of England. He was the founder of the Royal Agricultural Society, and for sixteen years discharged the laborious task of editor gratuitously. Mr. Morton evidently did not think landowners particularly wise; but they were not all so stupid that they did not try to inform themselves, and not all so ungrateful to those who went before as not to feel that a sound mathematical and classical training laid the foundation of teaching them to learn from those who could teach. What he understood Mr. Morton to have been aiming at was this, that he did not think that a close, tough, and downtrodden soil, which had not been subsoiled, and turned, and worked, so as to let in the air and light to it, was the soil upon which you could cart loads of dung in the form of masses of undigested science. If you wanted agricultural science—one of the noblest there was—to grow, you must turn up the soil, and make that fit to receive it. His point was to cultivate the farmer for truth, for technical knowledge, experience, and business. A good deal might be said about model schools, and model farms, but it was very difficult not to sacrifice the farm to the school, or the school to the farm, and the model did not teach quite in the same way as a sensible farmer would teach his son or pupil. You did want the foundation of a sound education to begin with in everything. In no profession had that been more fully brought out, during the last twenty years, than in the medical profession. The great difficulty had been that demand in the medical schools for attendance at lectures on all possible subjects, which it was said were indispensable to make a doctor, but which it was found could not be grafted on to an untrained mind. What was the farmer to do? He lived in a thinly-populated district; half a century ago he sent his sons to the village school, and, now they were getting well-trained elementary schoolmasters, farmers would send their boys there again; but when they got to the sixth standard, what was to be done? The farmer could not have his son educated at home or in the village; a boarding-school meant £25 to £40 a year, and in the present state of things that was a serious matter to a farmer with four or five sons. Then it was suggested that local authorities might establish schools; but where was the need of putting a boarding school within ten miles; what did it matter whether it were ten miles off or fifty? The great difficulty they were beginning to find now was starting too many schools. The local authority might do something in the way of supplying instructors to go round, but then they met with the difficulty of the Code and the time table, and the danger of not securing the grant. He thought Mr. Morton had hit the right nail on the head in insisting on a good general education as a foundation. He believed that a little sound training in mathematics and mechanics would be one of the best means of inspiring in the farmer that confidence in solid unmistakeable truth, which might dispose him to believe in knowledge when rightly acquired through the inductive method.

Mr. WELLS seconded the motion. He said he was especially connected with the chemical work of the Royal Agricultural Society, and he thought there was great progress being made in that department, which was more or less typical of what was going on in other directions. A farmer now, in order to profit by what was going on, must at any rate have some knowledge of science, and even if it was only nomenclature, that was some help to him. He had been rather struck by the remarks of Professor Wrightson as to the interest shown by landowners in agricultural science; but they were certainly not as awake to its importance as they should be, for you often found the heir to a large estate, who, if he were the elder son of a merchant, would be carefully brought up to his father's business, absolutely without any idea of agricultural knowledge. He hoped that out of the present agricultural depression some good would flow, and that all, both young and old, would find they must pay more attention to the industry upon which they depended for their existence.

The vote of thanks was carried unanimously, and briefly acknowledged by Mr. MORTON.

Correspondence.

THE PURITY OF BEER.

In replying, finally, to Mr. Stopes in connection with this subject, and his views as to the inferences deducible from the published statistics with respect to the amount of sugar used in brewing, it will avoid confusion that may arise from the mass of figures that may have been quoted, if I briefly reiterate the contentions which I am prepared to maintain, and point out the discrepancies between Mr. Stopes' arguments and my own :—

1. I state that the use of sugar has increased since the repeal of the malt tax, to the extent of about 18 per cent.

2. I prove this statement by adding together the

total amount of sugar used since the repeal of the malt tax, taking the average annual consumption of that amount, and comparing it with the amount used before the repeal of the malt tax; such a comparison gives the increase amounting to the figure mentioned by me.

3. I confirm that figure by reference to the published Parliamentary returns, giving from year to year the ratio of malt to sugar, and I find as the result of that calculation, that the increase stated by me is satisfactorily accounted for.

4. In stating that there has been an increase in the use of sugar since the repeal of the malt tax, I am of opinion that the fair way to test such a statement is to make the calculations over a series of successive years, and to compare the figures thus obtained with the figures obtained for a series of successive years before the repeal of the malt tax. I have adopted this plan, and have obtained the results which I have submitted to your Society. Mr. Stopes evidently considers this method of calculation unreliable, and prefers for the purpose of his argument to compare one particular year since the repeal of the malt tax with any one particular year before it, and thus to deduce his calculations. Hence in this respect our differences of figures arise from the variation in our mode of attacking the problem. I am quite content that your readers should judge between us as to which has adopted the more logical course.

5. Mr. Stopes objects to my statement that the year 1880 was an abnormal one with respect to the use of sugar by brewers, and he further states that "it is not supported by fact." In replying to this statement, I would quote the view taken by the *Brewers' Journal* of the 15th May, 1882. In that publication, in an article upon the subject, the fiscal year ending March 30th, 1882, is taken as the first entire year of the beer duty, and the article in question states that "the first budget which dealt with the beer duty was incomplete, and the deductions which it was possible to make, at most, could only be problematical. Giving the first six months as a trial, we have now a complete year's transactions to draw conclusions from." Moreover, Mr. Gladstone, in his budget speech of April 24th, 1882, said:—"The estimate which I gave last year [that is, in April, 1881] for the beer duty was £8,800,000, and the committee will be good enough to bear in mind that this is the first complete year that we have had to deal with the beer duty; the year 1880-81 was a mixed year, and therefore is not available for purposes of comparison. This [1881-2] is a year of beer duty, and nothing but beer duty." Again he said, "the last complete year of the malt duty was 1879-80, during which period the harvests were bad, and the depression of trade was so great that there is no fair standard of comparison;" in consequence whereof he took for comparison the six preceding years of the malt duty, and averaged the result.

I think that the above quotations will sufficiently justify my statement that the year 1880 was an abnormal one. If I am not sufficiently justified in the statement, then I can only say that Mr. Stopes had better attempt to controvert the views of Mr. Gladstone upon this subject; in any case, it will not be denied that I possess very good authority for the statement I have made.

I would further point out that in the year ending March 31st, 1881, the malt drawback had to be paid out of the surplus beer duty. In addition to this, the disturbance to the trade for the half-year ending March, 1881, owing to the stock-taking of revenue officers, was very great. Referring to this, the *Brewers' Journal*, of January 15th, 1882, says, "The number of mistakes made were so numerous that it was impossible for the Board to deal with them in the ordinary routine fashion, so that the Board had to issue the order in question to wipe them off the books, and put matters straight." The order alluded to was an absolving one of a sweeping nature, permitting officers to exercise a very wide discretion for a limited time.

I do not think it necessary in the interests of your readers, nor of the case for which I have ventured to speak, to further prolong this controversy. Mr. Stopes may fairly contend that the repeal of the malt tax has encouraged the introduction of foreign barley into the mash tun in place of English barley, and that it is only by using malt adjuncts that English barleys of inferior kinds can by any possibility compete with the foreign barley malt. If this is his contention, I am at one with him upon the point. He may further state that had no foreign barley been introduced into English breweries as the result of the repeal of the malt tax, that the amount of sugar used in brewing would have gone on increasing until it had attained proportions quite as great as that now officially returned; such a contention is purely a negative one. Mr. Stopes may hold this opinion, but it is utterly impossible for him to prove it; assuming that he could do so, it would be absolutely beside the argument which I have advanced.

ALFRED GORDON SALAMON.

[This correspondence must now close.—ED.]

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MAY 11.—"Cottage Industries in Ireland." By MRS. ERNEST HART. Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.S.I., will preside.

MAY 18.—"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S. SIR FREDERICK BRAMWELL, D.C.L., F.R.S., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MAY 27.—"Indian Tea." By DR. T. BERRY WHITE. H. S. KING, M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 10.—"The Architecture of London Streets." By E. J. TARVER, F.S.A. E. C. ROBINS, F.S.A., will preside.

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE. PROF. HUBERT HERKOMER, A.R.A., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 17.—"The West Indies at the Colonial and Indian Exhibition." By SIR AUGUSTUS ADDERLEY, K.C.M.G.

CANTOR LECTURES.

The Fifth and Concluding Course will be on "The Chemistry of Substances taking part in Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

LECTURE II.—MAY 9.—Resolution of complex into simpler substance during fermentation and putrefaction.—Classification of common substances produced during putrefaction.—Special characters of the proximate and ultimate products.

LECTURE III.—MAY 16.—Methods of retarding and preventing putrefaction.—Physical conditions least favourable to putrefaction.—General classification of chemical methods adopted for the prevention of putrefaction.

LECTURE IV.—MAY 23.—Special consideration of the chemical substances employed.—Antiseptics.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. M. Thomson, "The Chemistry of Substances taking part in Putrefaction and Antisepsis." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

TUESDAY, MAY 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. E. J. Tarver, "The Architecture of London Streets."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Ayrton, "Electricity." (Lecture IV.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. L. H. Ransome, "The Conversion of Timber by Circular and Band Saws in the Saginaw Valley, U.S.A."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. Prof. Victor Horsley, "On the Operation of Trephining during the Neolithic period in Europe, and on the Probable Method and Object of its Performance."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Dr. Thorne Thorne, "Infectious Diseases and Methods of Disinfection."

Colonial Institute, Prince's-hall, Piccadilly, W., 8 p.m. Mr. George Baden-Powell, "Colonial Government Securities."

Horticultural, South Kensington, S.W., 11 a.m. Fruit and Floral Committee.

WEDNESDAY, MAY 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mrs. Ernest Hart, "Cottage Industries in Ireland."

Geological, Burlington-house, W., 8 p.m. 1. Prof. T. H. Huxley, "Further Observations on *Hyperodapedon Gordoni*." 2. Rev. A. W. Rowe, "The Rocks of the Essex Drift." 3. Mr. E. T. Newton, "The Remains of Fishes from the Keuper of Warwick and Nottingham;" with Notes on their Mode of Occurrence, by the Rev. P. B. Brodie and Mr. E. Wilson. 4. Mr. Arthur W. Waters, "Tertiary Cyclostomatous Bryozoa from New Zealand."

Microscopical, King's College, W.C., 8 p.m. Dr. Maddock, "The Different Tissues found in the Muscle of a Mummy."

United Service Inst., Whitehall-yard, S.W., 3 p.m. Lieut. C. Bell, "Coating Ships of War at Sea."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Mr. A. V. Newton, "The Compulsory Working of Patents." 2. Mr. Davies, "Threats of Legal Proceedings."

Shelley, University College, Gower-street, W.C., 8 p.m. Concert of Shelley's Works.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Annual General Meeting.

THURSDAY, MAY 12...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 1½ p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture IV.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Adjourned discussion, "Measuring the Co-efficients of Self and Mutual Induction." 2. Professors W. E. Ayrton and John Perry, "Driving a Dynamo with a very short Belt."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 13...United Service Inst., Whitehall-yard, S.W., 3 p.m. Colonel G. G. Walker, "The Officering of the Militia."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. J. S. Burdon Sanderson, "Some Electrical Fishes."

Astronomical, Burlington-house, W., 8 p.m.

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Mr. J. F. J. Sykes, "General Powers and Duties of Inspectors of Nuisances, Methods of Inspection, &c."

Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

New Shakspere, University College, W.C., 8 p.m. Musical Entertainment, Selection of Shakespeare's Madrigals, Glees, &c.

SATURDAY, MAY 14...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. Ernest C. Rimington, "A Modification of a Method of Maxwell's for Measuring the Co-efficient of Self-Induction." 2. Professor S. P. Thompson, "Note on Transformers for Electrical Distribution."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. W. Hales, "Victorian Literature." (Lecture I.)

Journal of the Society of Arts.

No. 1,799. Vol. XXXV.

FRIDAY, MAY 13, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 15th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each. Not more than four tickets will be sold to any one member, and not more than 2,000 in all. When 2,000 have been disposed of, the issue will be stopped.

Tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter, a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, &c.) will be supplied. No refreshments can be obtained by purchase.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient. The members' invitations will be issued shortly. Visitors' tickets can be purchased from the present date.

Further particulars as to the arrangements will be announced in future numbers of the *Journal*.

CANTOR LECTURES.

Mr. J. M. Thomson delivered the second lecture of his course on "The Chemistry of Substances taking part in Putrefaction and Antisepsis," on Monday evening, 9th inst.

The lectures will be printed in the *Journal* during the summer recess.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen under the following classes:—

1. Prizes are offered to Art-workmen in certain classes of Art-workmanship enumerated below. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—

   (i.) Copies of existing works.
   (ii.) Modifications of existing works.
   (iii.) Original works.

4. In awarding the prizes, the judges will take into account the following points:—

   1. Originality or beauty of design.
   2. Fitness of treatment.
   3. Excellence of workmanship.

5. Before the award of prizes is finally made the candidates must be prepared, if called upon, to satisfy the Council of their competency.

6. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

7. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for any accident or damage of any kind.

8. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

9. All the prizes are open to male and female competitors on equal terms.

10. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

11. All articles for competition must be sent in to the Society's House on or before Saturday, 3rd December, 1887, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope giving the name and address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House, or, if the necessary arrangements can be made, at the South Kensington Museum.

12. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the discretion of the judges.

Prizes are offered in the following eight classes for the present year as follows :—

1. Painted glass, £25, £15, £10.*
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.*
7. Hand-tooled Bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 10, 1887; EDWARD C. ROBINS, F.S.A., in the chair.

The CHAIRMAN, in introducing Mr. Tarver to the meeting, said—The architecture of a city is dependent on the materials available for its construction for its general tone of expression. Thus the local stones of Bath, of Edinburgh, and of Paris, tell their own story. But no city has a greater variety of building materials at its disposal than London. That which is indigenous to its soil, however, is clay, and that which is chiefly used in the mass of dwelling-houses and warehouses, &c., is brick. Therefore, the treatment of clay, as a building raw material, is at the bottom of any great improvements in the mass of London house property. Colour is, however, obtainable in the various hues of brick and terra-cotta. But colour is visible only so long as it is uncovered by soot, and soot covers everything in London, and is absorbed by every porous building material. Consequently, black is the general hue of London, because absorbent bricks and absorbent stone are the common materials in use. To render our materials non-porous is therefore essential to the retention of their beauty, to the preservation of their parts, and to general sanitation. But no architecture and no materials will in themselves make a beautiful city, if designs are jumbled up together without order or selection. Without any organisation to control the construction of the main thoroughfares or the approaches to public buildings, unhappy results must ensue. The grouping of blocks of buildings for picturesque effect—having special reference to the skyline formed by the roofs, towers, and spires, the gables and dormers, and other accessory details—is essential for the purpose in view.

The paper read was—

THE ARCHITECTURE OF LONDON STREETS.

By EDWARD J. TARVER, F.S.A.

I have to crave your indulgence for the shortcomings of this paper, the preparation of which has been curtailed by other pressing engagements. When invited to take up

the subject, I felt much honoured by the request, and I could not but admit that it is a subject to which I have devoted a good deal of attention, especially of late. An old habit of looking about, in towns, for picturesque effects and groupings, and of considering how the unfinished portions of such towns can be best completed, induced me to apply for the office lately vacant at the Metropolitan Board of Works, through the illness and subsequent death of Mr. Vulliamy, an officer who always showed me the greatest kindness when I had occasion to consult him. The choice, as you all know, ultimately fell upon Mr. Blashill, who is—if I may be allowed to say so—eminently fitted for the post.

I take the liberty of mentioning this personal matter, because it led to my seeing one member of the Board in April, 1886, on the subject of re-completing the neighbourhood of Piccadilly-circus, and to my making a plan, recently published in the *Builder*, which has partly led to my appearance here this evening. I do not, however, intend to allude any further to a matter which is now probably in Mr. Blashill's hands. I was, I believe, the first to call attention publicly in the *Builder* of October, 25th, 1885, to the state of chaos left by the removal of an important factor in the symmetry of Nash's grand thoroughfare from Regent's-park to Waterloo-place, and we may confidently trust to see the recompletion of this space carried out in a manner worthy of London.

Neither do I intend, in the course of this paper, to indulge in vain regrets as to the position or design of any new buildings that may have been recently erected. It is more philosophical to take things as they are, and to make the best of them, but to be careful in doing so, that all the surrounding circumstances be taken into account; in fact, the duty to be steadily borne in mind when altering our towns may be summed up in one word—circumspection. To paraphrase a well-known epitaph, with a slightly different meaning, "*Si monumenta retinebis, circumspice*" before you destroy or rebuild. But this circumspection may prove to be perfectly fruitless unless all the official persons chiefly connected therewith understand one another, and act together for the public good.

There is generally some underground engineering work connected with street improvements, and there is sure to be some compensation work, but each of these is subordinate to the palpable results that are to minister to the convenience of the wayfarers above ground, and it certainly appears to me that the architect should draw up the scheme for any public improvement before either the engineer or the valuing surveyor add their indispensable services to the consideration of the matter. If these gentlemen should find some insuperable difficulties in the way of carrying out the scheme, the architect is still the fittest person to prepare an alternative scheme to overcome such difficulties.

In this manner, we will suppose that a line of thoroughfare has been formed, making an easy and valuable connection between certain important districts, and capable of producing a fine architectural effect, when completed, by new buildings. We are next met by the question how those buildings will fall into their places in course of time, as the gaps become gradually filled up.

In England, and especially in our large towns, where every one is free to erect buildings of whatever size he likes, so long as they are carried out in conformity with certain Acts of Parliament as to structural and sanitary conditions, it is hardly possible that each should know what his neighbours are doing, still less possible that he should know what his neighbours are likely to do in the future. Nor would Englishmen submit to be bound down to build to one rigid line. Our liberty is too glorious a thing, when not abused, to be given up to a second Baron Haussmann.

And yet, it appears to me, that it is possible to establish a system by means of which the individual architects of our new buildings should be enabled to work together for the common good, and for the prevention of clashing discords in our street architecture.

As I said before, it is impossible for each man to know what his neighbours are doing; therefore it should be the business of one public officer to collect all the facts as they arise from time to time, and to record them on a series of documents which should be accessible to all.

In the case of new thoroughfares, this would be easy enough, but I would extend this fount of information, as far as possible, to entire towns. The first duty of the officer in charge of this system should be to make himself thoroughly acquainted with his town, not only from maps, but by personal inspection of every portion—no light duty to begin with. I think I see him, mounted on a steady horse, wearing a coat with several outside pockets, containing his maps, note books, and a sextant.

Armed with these, he takes his town methodically in districts, and passes up and down every street. Of course he will pay most attention to the main thoroughfares, as they affect the pleasure of the greatest number of wayfarers in their daily route to and from their business. And I may say here in passing, that the new omnibuses, with their roof seats facing forwards, afford the most enjoyable way of contemplating our street architecture. A Hansom cab may or may not be a quicker conveyance in our crowded thoroughfares, but the view from one is nothing as compared with that from the top of an omnibus.

To return, however, to the public officer. He will not neglect the smaller streets, for many of our most picturesque views are obtained in them, and besides, no one knows whether or not they may be removed or widened to make way for broader thoroughfares, which would throw into conspicuous prominence some hitherto concealed buildings. Where any important buildings exist, our officer will take a rough sketch of them in his book, or secure a photograph, and if he should know that there is any prospect of altering or widening the street, he will consider the most favourable point of view from which such buildings may be seen. A rectangular building, for instance, generally looks better at an angle than as seen straight in front of the spectator.

But the more important buildings have to be considered, not only as seen from their immediate neighbourhood, but as forming conspicuous objects from a distance. Here the sextant will be found useful, and the approximate height of every building that rises above the neighbouring housetops will be marked by our officer upon the Ordnance map which he carries about with him. The bench marks already figured on the map will supply the remaining information as to the altitude of the spot above Trinity datum level. The effect of a distant building depends very much upon the intermediate levels of the ground beyond which it is viewed.

In order to record the heights of important buildings in an easily comprehended manner, they will be marked in various colours upon a map already shaded in Indian ink, to denote the contours of the ground levels. For instance, all buildings over 200 feet high will be coloured bright red, all over 150 purple, over 100 yellow, over 70 green, over 50 blue. These heights, added to the contour levels, will enable any one to see, at a glance, the part that such buildings take in the general landscape, and an architect about to build a tower will know whether 150 feet will be lost in a valley, or prove a mere waste of his client's money on a hill.

As far as possible, it would be useful to have elevations of entire streets set up to a small scale; but the enormous size of some of our towns renders such vast labour out of the question. Fortunately, modern science comes to our aid in the shape of photography, and there are many streets which can now be recorded by the camera, without very much distortion, through a wide-angled lens.

As regards new thoroughfares, the case is very simple. As soon as the ground has been cleared and the road made, with its subway and sewer, an accurate elevation of each entire side can be drawn to the scale usually adopted for official block plans, say 1-40th inch to a foot. On this elevation, or rather section, taken through the centre of the road, the sewer, gas mains, and water mains, and all other underground structures can be shown; and, while the plan of the street shows the depth of the adjoining plots, and the position of the nearest houses, the elevation can also show the position of any ancient lights in those houses, measured up or down, as the case may be, from the new pavement level. Such information would often prevent much annoying delay in the erection of new buildings in the thoroughfare.

In order to obtain an idea of the actual appearance of the thoroughfare, the architect of any proposed building will naturally go and see it for himself; but supposing the land is eagerly taken up, and a hundred architects are all busy at work in their respective offices designing buildings of various sizes to be built on this thoroughfare, who can say whether the street, when finished, will make or mar the beauty of the town? It is here that I venture to submit that our public officer will be of real use.

Let each architect, so soon as he has formed a general outline of a building that will suit his client's wants, send his design by a messenger to our officer. He will have one or two rapid draughtsmen who will reduce to the required scale, the elevation and the roof plan. The latter is most important, as showing the position of the chimneys, which affects street architecture more than may be generally supposed. The messenger will take back the plan in half-an-hour, so that the architect will not suffer from that most inconvenient state of

being without his plans, which he is sure to want, if they are out of his office for even a day.

Our officer will then temporarily fasten the proposed designs on to the general elevation of the street, but this will not enable him to judge of their effect as seen in perspective, so he will place the elevation upright upon the plan of the street by means of a simple contrivance for keeping it in position.

If several architects are designing at the same time, he will invite them to come and see their elevations thus set up, and, without offering any comments of his own, which might be looked upon as an impertinence, the chances are that each architect will see his way to some modification that could, with advantage, be made in his design both as an individual building and as a part of the general street architecture.

It may here be safely remarked that there is not so much danger now as there was twenty years ago of an incongruity of style in the various designs. The majority of us are agreed upon certain general lines of treatment which are becoming more and prevalent every year, as shown, for instance, in the High Schools for Girls, built by our Chairman. I have too much admiration for ancient architecture to say that we have yet developed a style as uniform as that of any past age before the Renaissance, but I do consider that those who still cling to the reproduction of bygone styles, however beautiful in themselves, are putting a drag upon the wheel of progress, and I believe that they will be, in course of time, public-spirited enough to sink any predilections that they may have for any particular phase of the past, and to throw the weight of their genius and talent into the common cause, namely the development of a good workable modern style, suited to our wants and manners of life. M. Paul Sédille, the French architect, says in the *Gazette des Beaux Arts*, that we have already attained such a style, which is very satisfactory evidence from a foreigner. But, more than this, we may see that our style has been sufficiently matured to become the parent of a branch style in America, where, as in the case of local branches in the Middle Ages, it has produced a picturesque and quite original phase of its own.

We need not, therefore, fear that our new streets will present the juxtaposition of a deeply-moulded many-shafted early English front, a strictly-Palladian façade, and a so-called Victorian elevation. Our style is accumulating by the steady co-operation of most architects, and not by the individual originality of any one architect.

Hence it would follow that the designs temporarily featured by our public officer on to the general elevations of the street, would probably reveal a discordance, not in style, but in size and scale or composition amongst the several proposed blocks of building. And I venture to prophecy that the architects of them would be only too thankful to see how an alteration here or there would save their work from clashing with their neighbour's, and that, in some cases, they would be glad to re-draw their design in order to make it twice as effective as it would otherwise have been, while they were ignorant of its future surroundings. Supposing the ground to be taken up slowly, the first comer would still have the advantage of seeing the whole street plan from end to end, and of judging of the effect of his proposed building in comparison with the width of the thoroughfare, and he would also have the advantage of studying the contour map above-mentioned, and of realising the grouping of his building with existing structures.

Our officer would also be provided with a collection of boxwood patterns, in the shape of cubes and spires, with which he could put together a rough model of any proposed or existing building in the neighbourhood. As soon as the designs are settled to the mutual satisfaction of all parties—each having but one common object in view—the elevations would be redrawn by our officer's draughtsman in ink, and carefully coloured to represent the several building materials, and then be permanently fastened down on the general elevation, which would be available for the information of the next comer.

As regards the form of thoroughfares, I would suggest that if a street be perfectly straight, it should be as wide as possible, and that its width should control the height of the buildings on each side of it. A narrow, straight street with high buildings is a thing to be avoided, not only because of the sense of oppression and darkness caused by such lofty proportion, but also for the simple reason that the buildings in such a street cannot be seen and appreciated. If, however, a narrow and high proportion should be unavoidable, the street should not be straight, but slightly curved or wavy in plan.

A very slight deflection from rigid straight-

ness is sufficient to produce picturesque results, as may be seen in St. Martin's-lane, where the vertical form of the church spire so beautifully closes the wavy line of the street. Another charming view of this spire may be enjoyed from Chandos-street, just east of Bedfordbury. The exact spot, which I always make for, is the last rain-water pipe, westwards, on the new block of artisans' dwellings. The composition seen from here is very beautiful.

In connection with St. Martin's Church, the completion of the new Charing-cross-road calls for the most careful circumspection. The Board of Works have already set back the boundary of the road on the east of the National Gallery; but it is to be hoped that this boundary may be still further set back to a line parallel with the Gallery, which is destined to have an eastern frontage of suitable design sooner or later. If this frontage be kept on a line with the wing facing St. Martin's portico, a great object will have been achieved, for the tower and spire of the church will be visible from a fair portion of the new road. Had the original boundary been adhered to, and had the National Gallery been completed up to that boundary, the church would have been entirely obliterated from the new road until one came close upon it. But, as you are aware from the public newspapers, the Institute of Architects have, at the instance of their standing committee on art, suggested not only this improvement, but also that the space to the north of the National Gallery, including the plot still occupied by a surviving public house and another house next to it, should be acquired for the future enlargement of the Gallery.

This committee, of which I am an honorary secretary, called attention to this matter at the beginning of this year, begging the Institute to lay it before her Majesty's Office of Works and the trustees of the National Gallery, as well as the Board of Works; and we hope that our scheme may yet succeed, and that the Gallery may thus be separated by a broad road from the risk of fire. Besides this, such an extension of the Gallery would play an important part in the surrounding scenery, not only as a fitting *coup d'œil* from the new road, but as seen from the Strand along King William street, and—looking into the future—from Coventry-street and Leicester-square, when Green-street shall have been widened.

The obstruction offered to the road by the portico and steps of St. Martin's Church is a question that has to be very cautiously approached. Ruthless designs and suggestions have been made by persons who evidently have not considered how inseparably the upper flight of steps is connected with Gibbs's design of the church. Amongst these suggestions I have come across the following:—One was to remove the continuous flight, and to ascend to the portico by separate flights cut in between the columns. This has the effect of perching each column on a lofty pedestal, to do which would make Gibbs turn in his grave. Another is to cut back the portico to half its projection, thus robbing it of its due proportion to the church. Another is to move the portico bodily to the east end of the church, which is too impractical to deserve a moment's thought.

The lower flight of steps, in its present form, is not part of Gibbs's original design, as may be seen in views made of the church before the completion of Duncannon-street; and I see a way of removing a portion of these lower steps so as to add five feet to the roadway, and yet to preserve the pyramidal line at the meeting of Duncannon-street and Trafalgar-square.

While speaking of Trafalgar-square, it may be pointed out that there are two objects in this neighbourhood which may be considered as fixed points for very many years, if not centuries, to come. These are the centres of the National Gallery Dome and of the Nelson Column. They are both of them guiding lines in a classical composition, which will not bear a treatment of balance as opposed to one of symmetry. To explain what I mean, I would say that the Houses of Parliament present a perfectly balanced composition as opposed to the symmetrical centre and wings of the Gallery.

By drawing a line through these two points above-named and continuing it southwards, it will be found to strike, not the centre of the road known as Charing-cross-street, but the west side of it. It is therefore impossible, when approaching Trafalgar-square from the south, to obtain a symmetrical view of it and of the National Gallery beyond it, a failure which just mars what is otherwise fairly called the finest site in Europe.

No wonder, then, that the Institute of Architects, as well as many individual well-wishers to London, are now doing what they can to remedy this eccentricity. It is certainly hard upon Messrs. Drummond that they should have been allowed to build their new bank in what should be the centre of the road. I hope

that it is not unphilosophical to express a regret in this instance; on the contrary, I hope that the laying out of the new Admiralty and War-offices may be seized as an opportunity of setting the matter right.

Our chairman has especially interested himself in this question, and will, no doubt, show you that there are no insuperable difficulties in the way of solving it.

Looking southwards, from Trafalgar-square, the view is so fitly closed by the clock-tower of the Houses of Parliament, that its position must be an evidence of the genius of Sir Charles Barry. And while in this neighbourhood, I cannot refrain from mentioning the fine series of views which break upon the wayfarer as he walks southwards along the eastern pavement of Whitehall. At about Scotland-yard, he sees Inigo Jones's Banqueting-house of good Portland stone, and then, after Gwydyr-house, the trees in front of Montagu-house, behind the green foliage of which the Clock Tower rises in graceful proportion, the whole forming a group which Sir John Millais has immortalised in the pages of the *Cornhill Magazine*. As a matter of colour, I always feel the want of a little red, and wish that the quoins of Gwydyr-house could be taken out and replaced by red brick. The composition would then be as worthy of brush as it is of pencil.

Proceeding still southwards, fresh charms are in store, as the precincts of our glorious Abbey are gradually revealed, and by the time the pedestrian has reached the corner of Bridge-street, he must be stony-hearted indeed who does not enjoy the view of Westminster Palace, and the vast Abbey rising behind the comparatively small church of St. Margaret.

I alluded just now to the Clock Tower closing the view from Trafalgar-square. Sir Charles Barry has given evidence of the same genius by placing the Victoria Tower so that it closes the view southward from Piccadilly-circus.

I may be excused here for calling attention to a group of buildings first mentioned, I believe, by Mr. Beresford Hope, which may be seen from St. James's-park, namely, the Victoria Tower rising behind the centre of the Abbey. To look at this from inside the park enclosure, about opposite Marlborough-house, is a very economical way of adding a central tower to the Abbey.

There is another view in St. James's-park, from the suspension bridge over the ornamental water, which ought to be borne in mind when the site of Lord Carrington's house and its neighbourhood come to be built upon. I mean the view of the Horse Guards, which was evidently calculated for when the bridge was built and the park laid out.

A few hundred yards to the north side of the bridge there is a view of the Foreign-office reflected in the ornamental water beyond a foreground of lawn and shrubs, which may be thoroughly enjoyed when the western sun lights up that building. It is surprising to observe that the seats which are placed for seeing this view are seldom occupied by the better class of people. Such a garden in any Continental town would be rendered attractive, and would be thronged with loungers.

Of course, our humid climate is against outdoor enjoyments except in quite warm weather, and, I must add, except in fashionable quarters, such as certain portions of Hyde-park; but the successive exhibitions at South Kensington have somewhat mollified our reserve in these matters, and have shown that English people can be trusted to enjoy themselves out of doors, like those of other nations, without indulging in rudeness and horse-play.

St. James's-park, however, is a master-piece of landscape gardening, and intended for relaxation; therefore I approach, with some hesitation, the question of continuing the Mall through to Charing-cross, unless this thoroughfare be restricted, as our chairman has proposed, to Royal processions, as a substitute for ducking under the low arch of the Horse Guards.

St. James's-park has already been invaded, from Marlborough-house westwards, by a stream of cabs, and, if an improved public thoroughfare is required towards Victoria-station and South Belgravia, there is another way of providing it, as a friend of mine has suggested, namely, by continuing Pall-mall between Stafford-house and Bridgewater-house, and thence by a curved road, under which the footpaths of the Green-park could pass, to join the road in front of Buckingham Palace.

There are such important considerations involved in this scheme that it can only be mentioned as a bare possibility in the future; but I certainly consider that it would be the making of Pall-mall, which now comes to an undignified end westwards, though the view eastwards is well closed by the dome of the National Gallery; and it would render St. James's-park a safer place than at present

for nurses and children along the whole extent of the Mall.

While on the subject of our parks, I cannot help hoping that the connection between the arch now removed to the end of the straight line of Constitution-hill and the screen at the entrance to Hyde-park may be completed. At present, the arch and screen, being placed at an acute angle one with the other, have no obvious architectural connection, though they both are connected with the memory of the Duke of Wellington.

Now that a new statue of the Duke is in progress, there is an opportunity for treating these various *disjecta membra* as parts of a complete scheme. I speak with much hesitation on a subject which has already been considered by H.R.H. the Prince of Wales and an eminent committee, and there may be difficulties in the way of my proposal, as it involves placing a statue within Hyde-park. I think, however, that the circumstances would warrant the position. Starting, then, from the arch, which is so often approached by our Royal Family along Constitution-hill, I would place a line of equestrian statues of Wellington's generals to flank each side of the curved route between the arch and screen, and then, on passing through the screen, the culminating central object should be seen, namely, the statue of the great duke himself, placed just beyond the point where the carriages turn to the right or left on their way round the park. It would thus offer no obstruction to traffic, neither would the statues of the generals be close enough to obstruct the traffic along Piccadilly and towards Grosvenor-place; on the contrary, they would form convenient refuges on those long and dangerous crossings.

Having now got as far as Hyde-park, I would express the hope that, in course of time, we may see a good background of foliage behind the Podium of the Albert Memorial, the white colour of which is utterly lost as seen against the sky, which dazes the eye, and translates the fine sculpture into a mere grey strip.

While on the subject of parks, and the means of rendering them enjoyable, I would call attention to the garden which the Board of Works have so tastefully laid out behind the Victoria-embankment. Here, again, the advantages are only half obtained. Such a garden, in any foreign town, would be thronged with people taking their proper relaxation from the strife of business, but we shut it up at nightfall, and not only convert it into a solitude, but thus leave the Embankment itself to be a comparatively unfrequented thoroughfare, that has not been altogether free from danger to honest wayfarers.

A few years ago, a client of mine asked me to find a site for a flower market, which he was anxious to present to London, he bearing the expense of the ground and buildings, but, of course, hoping to make a profit out of letting the stalls. The plot of vacant ground at the foot of Adelphi-terrace, so hideous that it has to be concealed from the Embankment-garden by a thickly-planted mound, was suggested to me as a site for this market, and heartily approved of by my client, who said that nothing could more suitably adjoin a flower-garden than a flower market, and I had every reason to expect that permission would be given for a gateway between the two for the use of the yearly increasing occupants of the hotels and clubs in the neighbourhood.

The question of vehicular approach from the Strand side presented some difficulties, but in consultation with the proper official, there appeared a prospect of these difficulties being met. As to the market carts, I arranged for the laden ones entering by the Adelphi arches from the west, and for the empty ones departing by the steeper gradient in Durham-street, and no doubt their egress could be helped by mechanical means.

There exists, however, a view of the busy wharf which occupied this very site when the Brothers Adam contrived the Adelphi with the object of combining the business of the wharf with an access to their new building from the Strand, and this view shows a laden and an empty cart entering and departing respectively by the very routes that I had proposed. My client further offered to pave and whiten the dark Adelphi arches, and to illuminate them with electric light, and thus to convert these unsavoury haunts into brilliant approaches to his market.

It is unfortunate that the filthy smells of Covent-garden Market, where vegetables are sold in bulk, and where carthorses convert the neighbourhood into a manure heap, should have wafted their odour over the mere suggestion of a flower market. Most of the tenants of the Adelphi-terrace saw that a flower market under their very noses, with private approaches to its terrace roofs, would be a boon to them; but the freeholder was advised that the market might be a nuisance, and so the matter rests.

I have dwelt so long upon the West-end of

London that there is not time to pursue the subject eastwards in a manner worthy of it; there are, however, few more enjoyable walks, especially on a Sunday, when the road is clear of tall omnibuses, than that along the Strand and Fleet-street. St. Mary's Church (where we may hope to see the urns replaced on its steeple), and the elegant spire of St. Clement's beyond it, make one shudder at the thought of their removal. There must be other ways of making space for increased traffic.

On reaching Fleet-street, St. Paul's comes into view in the very happiest manner—that is to say, seen beyond the descending valley, and rising above the houses on the re-ascending Ludgate-hill. From Fleet-street the railway bridge is no eye-sore, but rather a valuable line of shadow in the middle distance, and after passing under it, the gradual revelation of the cathedral is, to my mind, far more enjoyable than any large open space could make it.

As we get eastward, an object constantly comes into view which I always look upon as both picturesque and thoroughly modern—I mean the Cistern Tower at Newgate. It fulfils its purpose without any artificial ornament, and is composed of two modest materials, stock-brick and iron.

Of all the picturesque views about the City, I know none finer than the view down Fore-street from Moorgate-street. From here the steeple of St. Giles, Cripplegate, placed at a bend in the road, closes the view in the most perfect way, and makes one hope that it may always be borne in mind when any local improvements are made.

I now come to a subject which affects our street architecture in another way, namely, the building materials used. Our atmosphere is so charged with deleterious gases that very few building stones can stand it, while bricks of an absorbent nature soon become black with immoveable dirt. At Messrs. Doulton's manufactory, next the South-Western railway, white terra-cotta has been used for the springers and keystones of window heads in a stock-brick wall; the bricks have turned to soot colour, while the terra-cotta forms spots of white. A successful combination of terra-cotta and red brick may be seen in the Penny Bank and St. Margaret's-mansions, in Victoria-street, a group of buildings most happily placed at a bend of the road, and, if I may say so, well worthy of its situation. I frequently go out of my way to see these buildings glow in the western sun on a summer evening. A building entirely of terra-cotta may be too staringly clean to be pleasant, and may be utterly wanting in tone. A front of glazed materials, again, is a dangerous thing to tackle. The examples that I have seen in London do not tempt me to wish to repeat the experiment externally. Internally such material maybe effectively employed, as in a well-known restaurant near Oxford-circus; but in a private house, or in an establishment as nearly approaching privacy as a club, one does not care for the cold comfort of a wall that can be swilled down.

Marble linings, when not too overpowering in their grain, have a transparent beauty which may sometimes recommend their use on walls, but this is a matter in which we have still a great deal to learn, in order to secure harmonious juxtaposition of colours; while for external work, most marbles fare as badly as stone.

In order to compare the relative durability of various building stones in London, I have consulted a most useful list of buildings and their materials, contributed to the *Builder* of September 18th, 1858, by Mr. Wyatt Papworth, and have visited the buildings list in hand.

Portland stone has stood by far the best, and it is to be hoped that some quarries may still be found to yield more of this beautiful material which brighten up the landscape with a fairy-like whiteness by no means wanting in tone.

In St. Paul's Cathedral, almost the only decayed portions are the sharp edges of the cornices, from which we may learn that it is not safe to copy classic mouldings too closely in our climate, but that we must invent some of our own. In Goldsmiths'-hall, Foster-lane, and in the Law Institution, in Chancery-lane, both built about fifty years ago, the Portland stone is wonderfully sharp and clean even in shelter.

It should be remarked that, where decay sets in, it is always worse in the sheltered portions than in those which get constantly washed by the rain. A drip is like a water-seal trap; it is one of those things of which "a little more than a little is by much too much." It must, of course, be sufficient to throw the rain off, and to prevent ugly smears on the wall, but one may see that the classic soffite is a mistake in London; the dirt with which our atmosphere is laden clings to it, and eats into it like a canker. The soffites of stone balconies should certainly be painted as often as the woodwork of a house.

The next best stone to Portland, as given in Mr. Papworth's list, I found to be Ketton, which he says is used for the steeple of St. Dunstan's Church in Fleet-street. Every crocket on the pinnacles looks perfect, and the stone retains its pleasant brown colour. Anston stone, as used in the County Fire Office in Cornhill, in 1854-5, is fairly sound, but the colour is uneven, and some parts decayed. Bath stone fares badly in Plowden-buildings, Middle Temple, built in 1830-1, where it is used for dressing and string courses. The deeply sunk Gothic mouldings offer as great a warning as the sharp classic edges. We must invent our own mouldings.

Exeter Hall, Strand, front exhibits wonderful sharpness, if it be the very Bath stone that was put up in 1830-1, but it has a coating which may have preserved it for now more than half a century, and further information as to this front would be welcome.

Bramley Fall stone, used in the plinth of the London and Westminster Bank, Lothbury, in 1837-8, is also decaying, and so is the granite used in the pedestals in front of the General Post-office, St. Martin's-le-Grand, in 1823-9, though it seems, judging from a distance, to have stood fairly well in the arcade at Christ's Hospital, built at the same time.

Caen stone has stood well, as far as general surface is concerned, at No. 22, Basinghall-street, though it is decayed where in shelter, and is rubbed off where the passing traffic touches it.

In conclusion, I should like to call attention to some of those little things about a town which go so far towards making one's life therein a pleasure or the contrary.

I have frequently looked in vain for the names of some of our streets—even of important ones—and a very stringent rule might, with advantage, be made of making it compulsory on the parish authorities to fix the name of a street on every corner of it, in the full light of a lamp, and not higher than the level of the first floor. The enamelled-iron name plates now in use have certainly the advantage of being legible so long as they are sound, but they are very apt to become decayed by moisture finding its way behind the enamelled surface, and then the mischief increases rapidly. I would suggest that plates made of elm or other suitable wood, with the name branded 1-8th of an inch into them with a hot iron, and the remainder of the surface painted a cream white, would be most durable. They should have a capping, with a drip to keep them clear of smears. If placed high up, they may with advantage be tilted forwards.

London is behind some other towns in the matter of placing the hours of collection on the wall and pillar boxes. They are generally hidden away, and carelessly dropped in, so that one has great difficulty in reading them. In Buxton, if not in many other towns, these little plates are placed by the postman on the outside, where they are quite legible, and yet perfectly secured by a bead when the door is locked

The tables of cab fares, again, are often so placed that no light falls on them, sometimes vertically on a lamp post, so that even the projection of the frame casts a long shadow from the gas above it. In Paris they have the good sense to place them at such an angle as to receive the light of the lamp.

Londoners are very long-suffering in such matters; perhaps they do not take any more notice of them than they do of other carelessnesses. Probably thousands of Londoners have passed over Westminster-bridge without noticing that some panels under the lamp posts are empty, although most of these panels are properly filled with their bronze heraldry.

London-bridge was, for a long time, disfigured by a ragged regiment of posts supporting telegraph wires all along the outside of the parapet, as may be seen on photographs taken of it while in that careless state. No foreign people would like such things in their towns, and I believe the fact of these being kept in such good order is due to the outdoor life of their inhabitants.

Compare the suburb of Auteuil, on the west of Paris, with the very best suburb of London, and we must admit that we might take more pride in our buildings and fence walls and roads than we do. Many of our thoroughfares are, in their general aspect, very fine, and worthy of all the care that we can devote to them, with which object in view we need not be too proud to take a few hints from abroad.

London looks shabby after a visit to Paris, but then—on the other hand—London looks charming after a visit to Manchester.

We only wait for smoke consumption, durable building materials and the possession of an eye for the beautiful in laying out our streets as well as in designing our buildings, and we need not fear the criticism of our successors.

DISCUSSION.

The CHAIRMAN said there was abundant matter for discussion in the paper, and there would necessarily be great difference of opinion as to how London should be treated; though everyone would agree that it was not exactly a paradise. Mr. Tarver, however, had been able to see a great many pretty places, and had scarcely drawn attention to anything which wanted very great change, excepting in things yet to come. Wherever he went he seemed to find something to admire, whereas the habit of some people was to criticise everything adversely. There was a pessimist view of all things English which seemed to delight most Englishmen, and it was a great encouragement to find a gentleman with so much genuine artistic feeling able to give a long paper on the subject of London, and yet scarcely point out anything which was so ugly that it needed a very great change. The Chairman then explained, by means of two drawings, the improvements which he had suggested in Messrs. Leemings' design for the Government offices, Whitehall, by the enlargement of the site and the widening of Charing-cross, in accordance with the suggestion made by the Royal Institute of British Architects. By this amended plan Drummond's bank would be removed, and rebuilt in the rear of its present position, thus throwing a much greater width into the approach from Whitehall. The plan also showed how the entrance to the Mall may be doubled in width. The King Charles statue would also be brought into a line with the centre of Charing-cross and with the Nelson column. The additional cost would be about £200,000.

Professor KERR, referring to the Chairman's suggested plans, said he would carry the question a step further. When the plans of the Institute were published, it occurred to him to take the axial line from the centre of the dome of the National Gallery through the Nelson Column, which was the true axial line of Trafalgar-square, and produce it along Whitehall, and he found it nearly parallel with the front of the Horse Guards. He, therefore, suggested taking down Drummond's bank, and by bringing down a little the proposed front line of Messrs. Leeming's building, you would get, what the French always insisted on, a straight street. He did not object to a curved line sometimes, as Mr. Tarver suggested, in suitable circumstances, but he did object to a great axial line which was just a little bit out of the square, so as to destroy the vista. He sent his plan to some of the authorities, and had heard no more of it; but if the matter were to be discussed in public, he should certainly bring it forward, as it would secure a good vista up and down to and from Trafalgar-square. The old houses on the other side of Charing-cross would, it was hoped, in course of time, be pulled down and rebuilt. Another matter in connection with Trafalgar-square was the vacant pedestal which must have distressed them all so long. There was a very fine figure of George IV. on the other pedestal, and he thought it would be a very appropriate thing this year if a statue of the Duke of Kent were put on the vacant pedestal; it would help much to beautify London. Looking to the general question of the laying out of London in the future, the principal point was the re-edification of old streets, and, of course, the occasional building of a new one. He hoped Mr. Blashill would try to make his streets straight, and to persuade his Board not to deviate round every brewery or shop that happened to have a large business attached to it, but, in some reasonable manner, to follow the Napoleonic method of going in straight lines. He remembered the case of an important town in Scotland, whose authorities, some 60 years ago, determined to make a new street; they made it quite straight from one end of the town to the other, and though it brought them into the Bankruptcy Court, it was the foundation of the prosperity of the town. He held if there were a little less consideration of breweries and such things in London, it would not only produce a better effect on the eye, but would pay better in the end. As regards the rebuilding of existing houses, it was the peculiar charm of London as compared with Paris—though he had always been a great admirer of the latter city—that here there was so much individualisation in the rebuilding. Mr. Tarver had said something about the need for some authority to set out new streets on a plan, so that everyone might see what was going to be done, and that the respective architects might modify their views; but it seemed to him that if they were to interfere with the individuality of single buildings, they would not only be doing harm to the architectural effect of London, but would be doing violence to Mr. Tarver's own private opinion; for he had heard him again and again descant on the necessity of retaining that individuality. When you saw twenty buildings in a line, all symmetrical, the *ensemble* might be grand, but the eye soon got tired of it; but when the twenty buildings forming the line were each individualised, it might be a little too much so in some cases, still there was more life, and a better artistic effect on the whole. Therefore, he should like to see a more grandiose *ensemble* in the London streets; he would not lose the individuality of design in the separate buildings, and thought that characteristic should be maintained in an increasing rather than a diminishing ratio. The streets in the City were worthy of great admiration; he never went into the City without discovering new effects, and he doubted if so much had been done in the way of architectural improvement in any town in the world. There was an appearance of solid, substantial, enduring wealth, coupled with grace and elegance, frequently of a superior kind, which was most encouraging. He believed that English art and English architecture was destined, in another generation or two, to take

the lead in the world. He had said so many times, and he believed the opinion was gaining ground. They all knew the superiority of French art of the last two or three generations, the value of German architecture, and the precise value of Italian architecture, but all these forms of the Renaissance whether Classical or Gothic, lacked vigour. Even the French, which had an infinite delicacy and grace, was, to a certain extent, effeminate; but there was no sign of this in English art, and all over the world the influence of the English subsection of modern civilisation was a vigorous influence, and one which would manifest itself in art, as in commerce and everything else, in the form of straightforward up-and-down manly virtue. There were some who would not recognise the improvement in art, who still hoped that the 13th century might crop up again, and that we might go back to a previous stage of existence; but nothing of the sort was likely to happen. In London he hoped we should go forward in our own way, and that in architecture, as in everything else, we should exhibit a manly vigour which would in due time give us that ascendancy which he ventured to prophecy.

Mr. WALTER CRANE said he could not follow Professor Kerr in the rose-coloured view he took of London architecture and the English race, although he by no means expected to see the 13th century dawn again. He did not feel competent to offer an opinion on the various plans exhibited for the proposed London alterations, but it seemed to him that Mr. Tarver had offered suggestions which were both ingenious and valuable. Judging from certain improvements, as they were called, which had taken place in modern London, he rather shuddered at any further proceedings in that direction. In this point of view he must say that extremes met; an architect dealing with London was somewhat like a backwoodsman in a primeval forest, in both cases a clearing had to be made before anything could be done; but certainly architects' powers seemed to be inferior to the backwoodsman's, judging by the results. Great holes had to be made which destroyed the plans and proportions of the former architecture, and apparently nothing was left in their place. At least, it was only too obvious that the openings were made for practical purposes, to increase the traffic, and that was not an architectural object, and, therefore, the less said about the architecture in connection with such improvements the better. He did not know that he had anything of value to suggest in the way of materials. He had often been fascinated by the theory that much might be done in London by the use of coloured glazed tiles, or even, if possible, the adaptation of friezes on public buildings, but the experiment had yet to be tried. If tiles of a really good colour could be obtained, so as to harmonise with the rest of the building, it would be a good thing. But it was a question whether you could get anything to harmonise with the peculiar blackness of London; the tiles would remain fresh, while the wall would get blacker. You might perhaps cover the whole face of the building with tiles. There was one method to which he was very partial, but whether it would stand well in London he could not say—the *sgraffitto*, which was used in Rome and Florence for entire house fronts, elaborate designs being employed. There they looked clear and bright enough, but he did not know how they would answer here. He understood that some architects had introduced it in the shape of panels internally, but was not aware of its being tried externally.

Mr. TARVER asked if Mr. Crane was not in favour of mosaic work?

Mr. CRANE said that was one of the best methods of external decoration, but hitherto its enormous expense had been an obstacle. There was no necessity, however, that the materials should be expensive. All kinds of things might be employed, such as pebbles from the seashore, which were often beautifully coloured. Another material, nearer home, was the enormous mass of broken china which must exist somewhere, and this, when broken into small pieces, might be made to form very charming patterns. This was not a notion of his own, but was carried out by the Home Arts Association.

Mr. W. WOODWARD said he was interested in in this subject, first, as the holder of one of the Westgarth prizes for designs for the reconstruction of central London, and secondly, as an architect. Westminster-bridge was a point from which could be obtained one of the grandest ideas of London; the bridge itself was a masterpiece of engineering and architectural skill, and from it you could also see the Abbey, the Houses of Parliament, and the grand amphitheatre of architecture, as they hoped it would be, stretching from Westminster to Waterloo-bridge, and terminated by the grand river front of Somerset-house. A subject of growing importance was the offensive manner in which the fronts of street houses were now being treated; anyone walking along the Strand from Charing-cross to Temple-bar, could not fail to be struck with the unsightly bill-sticking which destroyed all street architecture. He was not sure whether the planting of a board over the whole surface of a street front did not come within the provisions of the Metropolitan Building Act, and if it did he should be very glad if some district surveyor would call attention to it. The plan for opening Charing-cross to the Mall had occupied the attention of a great many architects, and was included in the design which he had submitted to the Society; the idea was originally promulgated many years ago. The chairman's idea seemed a very admirable one, and so did that of Professor Kerr. With regard to Buckingham-palace, he thought it need not be considered in any such scheme. It was a palace

quite unfitted for the Sovereign of so great a country as this, and the sooner it was demolished the better. With regard to the formation of new streets, of course Mr. Blashill would understand that anything he said could not be directed against him, as he had only just entered on his duties, but he was quite prepared to prove, and had done so at the Institute of British Architects, that the whole of the recent street formation of the Metropolitan Board was simply a huge blunder. In the new street at Bloomsbury, in order to keep up a public house and distillery, a magnificent thoroughfare had been spoilt; the same idea prevailed in the new Charing-cross-street, and prevailed everywhere, the whole of the new streets were spoilt for the sake of not interfering with public houses, and the sooner public attention was directed to this point the better. Again, with regard to open spaces, Lord Brabazon's association, of which he was the honorary architect, had done much to prevent the Metropolitan Board from covering in what should be the open space in Bloomsbury. There the intention was to cover a little triangular space with building, but the intervention of Lord Brabazon had secured a little space of green which would delight the eye, and add to the lungs of London, which were a necessary of life. With regard to the gardens on the Victoria-embankment, they were very splendid, and if the buildings put up there, and the railway stations, were in accordance with the gardens, their attractiveness would be much increased; but the South-Eastern Railway Station and the Temple Station were horribly out of keeping in their surroundings. He did not agree with Mr. Tarver as to the railway bridge at Ludgate-hill, which he considered a great eyesore. With regard to materials, there was a large building now being erected in Fetter-lane, the front of which would be entirely of white glazed bricks; he believed it was done principally to satisfy the neighbours on the question of light, and what the effect would be he did not yet quite know. No allusion he understood had been made to Cors Hill stone or Dumfries stone, which was now being largely used.

Mr. Tarver said he had only referred to materials which had been in use some time.

Mr. Woodward said at the Geological Museum, in Jermyn-street, he had noticed that the sill of one window was quite decayed, whilst that of another adjoining window was thoroughly sound. There was evidently need for further legislation. In Rome and other continental cities, in the case of any proposed new line of thoroughfare, the plans were exhibited publicly for fifteen days before the project was entertained, and he thought something of the kind should be done in London, in order to prevent a repetition of what he ventured to call the horrible blunders of the Metropolitan Board.

Mr. G. H. Birch said his studies had been rather devoted to ancient than to modern buildings, but he wished to express his great thanks to Mr. Tarver for his valuable paper. He had only just returned from the United States, where, as a new country, one would have expected all those blunders and excrescences which had accumulated in London would be absent; but he must say, from his observation in New York, that this was not so. That was a city of nearly 15 miles in length, with an average width of from 2 to 2½ wide, laid out in a perfectly regular manner, with ten avenues going from one end to the other, intersected by 179 streets; and if there ever was a mistake in laying out a city, New York was a most glaring instance of it. Anything more monotonous or wearisome than those endless blocks of exactly spaced buildings could scarcely be imagined. Fortunately, uniformity of the buildings themselves had not been adhered to, and he did not know anything more picturesque than Broadway, which was an exception from the usual run of the streets, because it cut across the whole of them diagonally, but at a uniform width. There every person had done what he pleased, and the general effect was wonderfully picturesque. When people complained of unsightly hoardings in London, he would advise them to go to New York. Looking down Broadway was like looking at the ships in the docks. At intervals of about twenty yards there were enormous telegraph posts, with cross pieces carrying seventy or eighty wires on each side between the first and second-floor windows; he said nothing of the elevated railway, which only occurred in some few thoroughfares, and thoroughly obstructed everything.

Mr. Blashill said in the circumstances in which he was placed, he was rather debarred from originating anything in the discussion, but he would make a few remarks on this valuable paper. He was somewhat amused at Mr. Tarver's notion about the official inspector, but perhaps he did not know that, to a large extent, his suggestions were already carried out in the City, although that was the only portion of the metropolis where they were. For many years, every important part of the City had been thoroughly and carefully surveyed, and every part where an improvement was desirable, and at all practicable, was marked down, and the actual improvement drawn on paper long before anyone thought of dealing with the particular buildings which would ultimately have to be improved. There were inspectors appointed who had careful instructions, even to the extent of what implements they were to carry with them, and who had to communicate with the chief officer, and tell him the moment anything was done to any house, in order that at once that portion of the scheme which had already been thought out might be set on foot before the owner or occupier could commit himself to anything. The Commissioners of Sewers, and their able engineer, Colonel Heywood, were the authority under which that was done. Mr. Tarver had spoken of the pleasing views and landscapes of London, but he could only

say that there was no landscape in London, nor could there be under present conditions. He remembered the time when you could get on the top of certain high buildings, or even on Primrose-hill, and see something, but for many years past, whenever he had done so, he had entirely failed to see anything worth the labour of the ascent. The great evil from which they were suffering at present, which he hoped would sooner or later be cured, was the smoky condition of the atmosphere. He had been interested in the suggestions as to the way in which new streets were to be laid out by arrangement with the various architects, and was glad to say that in a few weeks these gentlemen would have an opportunity of putting this idea into practice, because the whole of the sites in certain large thoroughfares over which the Metropolitan Board had control would be put in the market, with the view of seeing them covered with buildings pleasing to the eye, and profitable both to the City and the persons who occupied them. With regard to the porch of St. Martin's Church, there was no doubt the road there very much wanted widening, and, indeed, Gibbs might turn in his grave if he knew all the propositions which had been made; but he could not help thinking that if he knew Mr. Tarver's suggestion, the only difference would be, that it would make him turn over on the other side. He would say a word or two as to the state of the buildings in London. There was no city in the world where such an entire absence of knowledge what to do with dirty buildings existed. If you went to Holland, you would see buildings washed up to the top of the first floor once a week whether they were clean or dirty; but in London, buildings infinitely superior in cost and in importance were not touched at all. Even the best people, who desired to do what was right, and who would not think of going into the street with a dirty face, were utterly callous to the fact that the fronts of their houses had never been washed for thirty years. He could scrape dirt off one important building a quarter of an inch thick, and had done so as an experiment. The owners of individual houses did the same thing. No one who had an ordinary intelligent interest in the matter would allow things to go on like that. Reference had been made to the view from St. James's-park, and while he was very pleased to see it used by well-dressed nursemaids, he was very much annoyed at seeing so many of a class such as you saw in no other city; low blackguards, filthy and repulsive in appearance, whom it was a pollution to come within yards of. Those were the kind of people who sat on the seats in the park, and in Trafalgar-square, the finest site in Europe, and until something was done to remove this glaring evil, those charming spots would never be properly utilised. The Thames-embankment had been mentioned also, and he had not the smallest doubt that the Metropolitan Board intended that that should be a pleasant lounge by day and night for respectable people, but it was nothing of the kind. The roadway at present was almost covered with cabs, and the place occupied only to a small extent. Nothing could be more charming than a walk along the quay at Rouen; it beat anything in Paris, and that was the nearest approach to what the Thames-embankment ought to be. As to the statues, he did not know anywhere but in London where a statue assumed, after a few weeks or more, the tint and appearance as if it had been blacked purposely by a mixture of soot and water. In Rome, at one time, there were 8,000 bronze statues, every one of which, in the open air, was gilded. In London there was only one gilded statue that he knew of, but in Hull there was an equestrian statue of George III., which had always been gilded within his recollection. Some years since he wrote to the *Times*, to suggest that the statues we could afford to gild should be gilded, and the others should be washed, but the suggestion was only treated as a joke. The use of mosaics had been mentioned, and he did not see why they should not be introduced. On the grand canal in Venice there was a splendid picture right out in the open, and why should there not be a similar work of art in front of Somerset-house. He remembered some years ago a lecture by Professor Donaldson, who had just been spending five years abroad, in which he said, that standing on Waterloo-bridge, and looking at Somerset-house, was to be seen a finer sight than anything he had seen while away, and there was no doubt a great deal in that. If we took more pride in our buildings, and kept them clean, the appearance of London would be wonderfully improved. As Professor Kerr reminded him, Sir Charles Barry had produced a fine design for uniting Pall-mall with the park.

Mr. H. B. Wheatley remarked that the subject of the paper divided itself into two portions, one the treatment of sites, and the other, the treatment of building materials and elevations. The city of London in the Middle Ages was probably as fine and picturesque as any other European city of the time, but unfortunately, during the 16th and 17th centuries, it gradually grew more and more ugly, until it became, perhaps, one of the ugliest cities in Europe. A great opportunity for improvement was missed at the time of the Great Fire. The plans of Wren, Robert Hooke, and Evelyn, all of which were good, would have helped to make it a fine city, supplied with open spaces and vistas, but these were rejected, and though Wren and Hooke superintended the rebuilding of London, they were not allowed to carry out their own farseeing and admirable schemes. The great cause of the loss of beauty in London was the neglect of the river, and the great object of all those who had for past centuries tried to improve London had been to have an embankment on the Thames. If you wanted to give a stranger a good view of London, you took him to one of the bridges, or the Embankment,

and from thence you could see as fine a city as any in Europe; but before the Embankment was made there was no place from which you could see the city at all; it was merely a confused heap of houses. The first great London improvement was the New-road, in 1755-6, but this was really outside the town. About 1766, John Gwynn, a London surveyor, and a friend of Dr. Johnson, published plans for the improvement of various roads, many of which had since been carried out, one of them being for the construction of a bridge where Waterloo-bridge now stood, with a road up Wellington-street, as at present, but with other streets that had not been carried out. Then came the great improvement of Regent-street in 1813, London-bridge in 1824, and the roads to it completed in 1831. Colonel Trench, in 1827, attempted unsuccessfully to obtain an embankment for London, and he made various other proposals, some of which were adopted, whilst others were not. One of these was for a long road from St. Paul's to Hyde-park, which would have been a grand thing in one way, though the cost would have been enormous. With regard to the second division of the subject, the treatment of elevations, credit ought to be given to the Brothers Adam, who did so much in that immediate neighbourhood. No city, probably, had streets so hideous as many of ours, consisting of nothing but brick walls, with holes for windows. The brothers Adam were the first to attempt an architectural effect with ordinary houses, and though their plan was not entirely in accordance with modern taste, they made a great improvement in the Adelphi and also in Portland-place. Nash followed the same plan in Regent-street, which had been so highly praised by Mr. Tarver. Many distinguished architects of the present day had helped to give colour and form to our streets, but the great pity was that these improvements sometimes brought out in greater contrast the ugliness of the surrounding houses. All would agree, he thought, with Professor Kerr as to the advantage of irregularity in buildings down a long street, but there was one point in which it might be carried too far, viz., when one man had spent much money and skill in putting up an admirable and finely proportioned building, for a neighbour to erect one so much higher as to dwarf and spoil it altogether. It was on such points as that, that a little more regulation seemed to be required.

The CHAIRMAN, referring to Mr. Blashill's suggestion that houses should be washed, said that in 1867 he saw public buildings in Paris cleaned with a steam jet in a manner he had never seen anywhere else; and, therefore, when some years ago he was requested to clean down the façade of Hanover Chapel, he went over to Paris to make inquiries about the process. He had great difficulty, owing to the changes which had taken place since the war, but ultimately he discovered that the method had been patented both in France and England. On his return, therefore, he hunted up the specification, found, luckily, that the patent had expired, and got an engineer to make him the apparatus. By using wet steam in this way, he was able to clean the whole front without scraping the stone at all; the black coating, which was simply an accumulation of soot, came off in flakes like leather, leaving the stone beneath perfectly sound and good. This was an admirable way of cleaning buildings where there were mouldings which might easily be injured by scraping, and he had, therefore, invited the late Mr. Street and one or two other architects to witness the process. He had used Caen stone thirty years ago, but not since, as he found it utterly unfit to stand the London atmosphere. A specimen might be seen in Library-buildings, Lincoln's-inn-fields. Bath-stone, although very soft, would weather, and become hard on the surface, if properly used, but if not perfectly good stone it sometimes became rotten in the process of hardening, in consequence of something in the atmosphere. It was, therefore, desirable to protect the surface for the first few years by covering it with a preserving solution, which gave it time to harden, after which a repetition of the process was not required. Tiles had been referred to by Mr. Crane, but he thought more would have been said about terra-cotta; this was simply brick of a finer quality, burnt so hard that it was not porous; the texture and colour might be just what you pleased to make it. The Natural History Museum was built entirely of terra-cotta, and although it had not been washed, it remained perfectly clean; it was as pleasant to look upon in point of cleanliness as any building in London. He had asked Mr. Waterhouse if he thought it possible to avoid mixing this terra-cotta with ordinary porous bricks, which got so black, and left the terra cotta looking as if it did not belong to the rest of the building, and he said he now had bricks made of the ordinary size as impermeable as terra-cotta, and in that way he got a building which would not retain moisture, and would require much less cleaning than any other material. Very charming effects could be obtained by terra cotta, owing to the irregularity of the jointing, which was much more pleasing to the eye than a series of perfectly straight lines, looking as if they had come from a machine. The Chairman regretted that there was no time left to say more on the subject, but he had wished to express a hope that the projected Imperial Institute, if finally erected at South Kensington, might be made the means of improving the surroundings by demolishing the unsightly shanties which now crowd up every avenue leading to the national collections. It was a disgrace to the time that the "Brompton Boilers" should still continue to exist alongside the projected facade of the Oratory adjoining.

Mr. TARVER, in reply, said his object was not in any way to cripple individuality, but simply to allow each architect to revise his own design by the light of his neighbour's. What Mr. Blashill had told

them about the City only showed the good result of the system he advocated. He could not agree that there were no landscapes in London. You could obtain them from any one of the bridges, especially early in the morning, and a friend of his, who returned to London from abroad at four o'clock in the morning, had remarked on the beauty of the view from one of the bridges. The want of outdoor life was, he believed, the great clue to the secret of the neglect of public buildings. The Dutch washed their houses constantly, and ours would be much improved thereby, and the statues also. He remembered on one occasion pointing out the statue of Sir Robert Peel, in the City, to a little nephew, who immediately asked if that statesman was a chimney sweep.

A vote of thanks was passed to Mr. Tarver on the motion of the CHAIRMAN, and the meeting adjourned.

TWENTIETH ORDINARY MEETING.

Wednesday, May 11th, 1887; SIR PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Buzzegoli, Joseph, 66, St. Augustine's-road, N.W.
Campbell, Hon. Dudley, 1, Mitre-court-buildings, Temple, E.C.
Letheren, W., Art Manufactory and Iron Works, Cheltenham.
Sadler, George William, 467, High-st., Cheltenham.
Walker, John Scarisbrick, 3, Alexandra-road, Southport, Lancashire, and Pagefield Iron Works, Wigan.

The following candidates were balloted for and duly elected members of the Society.

Stanton, Arthur Gwyer, 13, Rood-lane, E.C.
Stewart, Major-General John Shaw, 10, Gloucester-place, Hyde-park, W.

The paper read was—

THE COTTAGE INDUSTRIES OF IRELAND, WITH AN ACCOUNT OF THE WORK OF THE DONEGAL INDUSTRIAL FUND.

By MRS. ERNEST HART.

When, so long ago as in 1872, and bent solely on pleasure and holiday making, I first visited Ireland, I was struck by the strange and anomalous condition of the country, and questions to which I could obtain no satisfactory reply were always on my lips:—Why should a people so naturally gay in heart be so sunk in misery? Why should a people so truly religious in spirit be stirred to commit such terrible crimes? Why should an agricultural people have millions* of acres unreclaimed and unproductive, an island people with vast natural harbours be without ships and without fisheries? Why should a people who have shown themselves capable of performing such feats of industry stand idle half the year, and a people so strikingly intelligent be ignorant and illiterate beyond other nations? And wondering sadly at what I saw in Ireland, and comprehending it not, I was led to study her past history and her present condition, and feeling, as time went on, that the Irish question was the question on which it was the duty of every English man and woman to form a correct opinion, based on accurate knowledge, I came to perceive plainly that the political question (which I leave out of sight here altogether) is but part of the great Irish question, for underlying it is the economic question, with problems at least as difficult to solve—how to employ and how to feed the people. I started then from the simple first principle that a suffering people must claim our pity and command our help; and thus it was that, in the spring of 1883, I accompanied my husband on a tour of inquiry into Donegal and county Mayo, in order to personally examine into, and ascertain the actual condition of, the peasantry in the congested districts, the scenes of recurring famine.

THE CONDITIONS WHICH LED TO THE FOUNDATION OF THE DONEGAL INDUSTRIAL FUND.

I must, as a preliminary to the foundation of the Donegal Industrial Fund, describe the villages and county of Donegal, as this county is unlike anything to be found in the length and breadth of England. The rail ceases at Letterkenny, to which little market town—an outpost of civilisation—a branch line has been run from Londonderry. From here till the railway can be rejoined at Donegal town, a distance of about 180 miles, travelling must be accomplished in an open Irish car. For some distance round about Letterkenny the land has been reclaimed and

* Professor Baldwin puts the amount of reclaimable land in Ireland at 4,000,000 of acres (Evidence before the House of Lords). Mr. Dennis, in "Industrial Ireland," says there are 6,000,000 of acres which might be profitably worked.

cultivated, but on taking the road to the coast all traces of wellbeing and the pleasant green fields are soon left behind, and the road for thirty miles passes through the black bog-land of the Donegal highlands. Here and there tiny settlements may be seen, distinguished by green patches on some slope by a lonely lake; but these are scarce, and generally the bogs are given up to the snipe and woodcock, and to the maddening midges. The first village reached on descending from the uplands, and after a drive of six hours, is that of Gweedore, the destitution of which was the subject of an inquiry by a Select Committee of the House of Commons in 1858, of which the Blue-book is before me. Gweedore may be taken as a type of a congested village in Donegal, and as I am intimately acquainted with it from frequent visits, I may be allowed to describe it rather fully, in order to show what are the conditions of life and the surroundings which render cottage industries such valuable and, in fact, such necessary adjuncts to an agricultural population living on small holdings. Gweedore is situated on a broad slope of bogland stretching from the sea shore to the range of mountains, of which marble-topped Errigal and broad Muckish are the highest summits. The settlements, or so-called farms, carved out of the bog, may be distinguished on either side of the Dunlewy lake and Claddy river as soon as the mountains are crossed, but as we descend towards the sea they occur at more frequent intervals, until at last, by the shore, they lie close together in long narrow strips from eight to ten feet wide; or else, reduced to very small dimensions, they may be seen thickly scattered on the promontories which jut out into the sea. The tenants' houses or cabins can scarcely be distinguished from the huge boulders which cumber the ground. The whole of these farms have, without exception, been wild bogland, reclaimed by the unremitting toil of generations of honest peasants. These people were originally squatters, and are the lineal descendants of the mere "Irish," who were driven into the "lean lands" in the settlement of Ulster by James I., while the fair "fat lands," bordering Loch Foyle and Loch Swilly, were reserved for his Scotch and English followers. To understand congestion in Gweedore, it is necessary to try and realise the following facts and figures.* The parish contains 68,550 acres, most of which is boggy upland and mountain moorland; in the reclaimed arable land there are settled 1,777 small tenant farmers, whose families amount to 9,636 persons, being 0·33 persons to each acre of arable land. The acreage of a farm is from 5 to 10 acres, much of this being still in the bog condition, and the average rental of the holdings but 37s. a year. The helpless poverty of the place may be judged of by the fact that in the whole parish, 12 miles across, there are but 7 persons who pay a rental of over £4 a year, and only 8, who are rated as occupiers at £12, have the municipal vote. Four of these are Manchester men, lessees of the salmon fishing, one the housekeeper, one the storekeeper, one the Catholic priest, and one the Protestant clergyman, who has the vote, though his house is rated under £12. With the exception of those of the parish priest and the Protestant clergyman, there is not a single gentleman's house in the parish, and, again, with the same exception, there is no one of culture to bring "sweetness and light" to the people of this desolate district, no one to help them in their times of distress, no one to bring joy into their lives. But Gweedore is no isolated example of congestion and destitution. In the Rosses, Gweebarrow, Glencolumbkill, in fact, all along the Donegal sea-board, identical conditions prevail, and one may cross the country from Dunfanaghy to Killybegs, and from Dungloe to Stranorlar, an area of about 1,000 square miles, containing over 100,000 persons, and find the whole population at a dead level of destitution. Try for a moment to imagine such a state of things in England; picture such a district on the moors of Yorkshire, on the sandy reaches of Anglesea, on the barest part of Cornwall; imagine 100,000 people cut off from communicating, by railways, telegraphs, or newspapers, with the outer world; let a range of mountains and 30 miles of bog intervene between them and civilisation; imagine them left alone for generations in their poverty, ignorance, and misery, cultivating a soil inadequate to support life; realise that the urgent representations of their few friends that the means of education and employment might be granted these people, so that they might live, fell unheeded, till at last the cry of a famished and suffering people rang through the whole earth, and awoke us from our apathy. Such a state of things is inconceivable in England; in Ireland it is frequent, for the same sad story of congestion and destitution is repeated in County Kerry, County Mayo, and the Western Islands.

Mr. W. E. Forster, said, in 1847, and similar

* "Forty Years in the Desert," by Ernest Hart, reprinted from the *Fortnightly Review*, June, 1883.

conditions were repeated in 1879-83, "Famine is no new cry in Ireland; it is a periodic disease. For a large portion of the population of Ireland all the great purposes of existence are forgotten in a struggle with death." Mr. Tuke, speaking of a visit to Gweedore, in 1880, says, "Of the destitution and misery found in these bog dwellings, I feel I can hardly bring myself to write. It is not merely the unusual distress of to-day, but the every-day life, the normal condition of hundreds, nay, thousands of families on the west coast of Donegal which oppresses me." "The condition of the people of Mayo." says Mr. E. Perry, High Sheriff of the county, "is always precarious, and the first touch of misfortune places them on the verge of starvation." Weighty testimonies these, to the terrible condition of the people.

The census for 1881 furnishes us also with some remarkable figures which illustrate in a striking manner the poverty of the country, and bear upon the efforts which I am about to bring before your notice. In the entire county of Donegal, containing 206,000 inhabitants, there was in April, 1881, only one architect, one photographer, one railway guard, one accountant, one showman, one literary man, and one shorthand writer (the two latter completing the return of "literary and scientific persons" for the county), three cabinet makers, eighteen bricklayers, and 54,000 agriculturists. As an example of great opportunities thrown away, what can be more striking than that in a coast with a sea line of creeks and inlets of 680 miles in extent, and with a sea said to be "boiling" with fish, there were, in 1881, but 52 vessels. Of these, 2 were in the Government service, 31 engaged in coasting trade, 13 in inland navigation, 3 under local Boards, 1 in fishing, and none in pleasure. Poor Donegal the owner of one solitary fishing boat, while her seas are fished by fleets of boats from England, Scotland, Norway, and Holland.

Now, what do these Donegal peasants do, and how do they try to support life? This is the usual course of life on the farms. The crops, consisting chiefly of potatoes and oats, are planted in April or May, for the seasons are backward; the able-bodied men and large numbers of the girls and boys then migrate to Scotland and England to seek farm work as labourers, and to earn the money with which to pay the November rents, and to buy meal for the winter; while the married women and old men are left at home to look after the little farm and gather in the crops, In the autumn the migrants return home, and for the six winter months there is nothing for them to do, except to occasionally cut turf, gather sea-weed for manure, and tend the cattle, if any. The produce of the little farm, chiefly oats and potatoes, is not sold, but kept for the support of the family, and the spring rent is generally met by the sale of stock fed in the rough mountain pastures, or the earnings of the women in knitting and sewing. The enclosure of the great common pasture lands, which took place in Donegal about the year 1855, has been one of the chief causes of the impoverishment of the people,* but it is satisfactory to know that the 10,000 acres enclosed in Gweedore, in 1856,† have been restored to the tenant, and if it had not been for the sudden and unexpected depression in the price of stock during the past two years, the people of this village would, by regaining their grazing grounds, be in a better position from this cause alone than they have been for years. But the boon has come too late.

How did we find these Donegal people in 1883? For three years famine had been kept at bay by the heroic exertions of the Bishop of Raphoe and his priests, now aided by the Mansion-house and the Duchess of Marlborough's funds, and by subscriptions from America and the Quakers (the constant friends of Catholic Donegal), had organised a well-devised system of relief works, in which one able-bodied member of a family was selected to work at road-making at such a rate that he could earn a penny worth of Indian meal for each member of his family per diem.

Origin of the Donegal Industrial Fund.

In the spring of 1883, when my husband and I went on our tour of investigation in Donegal, towards the end of this three years' struggle with destitution, funds were exhausted, and the gravest fears were felt that what is called in official reports a "catastrophe," namely, deaths from actual famine, would occur before the crops sown by charity could be gathered. Sixteen thousand persons

* *Vide* "Visit to Donegal and Connaught, 1880," by James H. Tuke, in which a return is given, p. 115, showing the number of sheep and cattle reared by the tenants of Meenacladdy and townland of Gweedore before enclosure and afterwards in 1880. The figures are: cattle, before enclosure, 248; in 1880, 71; sheep, before enclosure, 928; after, 127.

† *Vide* "Evidence before the Select Committee of the House of Commons on the Destitution in Gweedore and Cloughaneely, 1858," p. 289.

were being fed by charity, and Mrs. Power-Lalor was feeding 40,000 children with biscuits; in fact, the whole Donegal people stood on the verge of starvation. What could we do to help to meet such an appalling state of things? To simply try and feed these starving people was naturally one's first impulse; to eat one's own dinner in comfort while thousands were crying for bread seemed to me like committing an outrage on humanity; but how to cure the terrible destitution I had witnessed, and how to prevent the recurrence of these famines, became the all absorbing thought of my mind. Pondering long on this question, I came to the conclusion that as these people were more or less fixed in the country by the tenure of their farms, in which was sunk the labour which is the capital of years, often of past generations of ancestors; that considering agriculture employed but half or less of the time of the family, and yet was sufficient to prevent them working in factories or towns; considering also their extraordinary isolation and removal from markets, bearing in mind also the characteristics of the people, their love of family life, their quickness and intelligence; and still more the unanimous and incessant demands made by them for work from one end of the county to the other; taking all these things into consideration, I came to the conclusion, that if cottage industries could be revived and developed amongst them, these would be supplementary to agricultural work, and would give employment during the six winter months of enforced idleness, and money thereby would be earned which would enable the peasant farmers to meet the spring and its liabilities with courage, and which would lift the people out of the pauperism into which they were inevitably sinking, into a condition of manly independence.

The First Steps.

I determined to try the experiment, and beginning in the early part of 1884 in the simplest and most amateurish manner, with only a few pounds of money with which to purchase a few pounds of yarn to give out for knitting, measuring and examining the socks, and weighing them on the letter weight in my study as they came by post from the knitters' hands, I have, after three years of incessant labour, succeeded in founding and organising industries which now give employment to over 800 workers, and which have the immediate prospect of considerable development.

The Part which the People took.

In this undertaking I could not have succeeded had I not been ably and admirably seconded by the people themselves, and the good opinion I formed of the Donegal peasantry when I first went among them in the period of their distress, has been confirmed by more intimate knowledge in all my subsequent dealings with them. Mr. Justice O'Hagan said, in 1884, that he found them "an honest, veracious, and industrious people." This verdict from so high an authority I entirely endorse. So honest have I found these peasants, that it has in the end proved unnecessary to adopt an elaborate system of checks. By those who know and do not misrepresent the Irish peasantry this great quality has always been granted. Mr. Fox, in his report to the Dublin Committee in the famine crisis of County Mayo in 1880, speaks of a house that was pointed out to him by a member of the police, which was filled from floor to ceiling with the pawned goods of the poor, and which was unprotected even at night, "such," as he remarks, "is the unimpaired honesty of this starving people." Their truthfulness I have had no occasion to doubt.

Their Eagerness to Work.

Of their industry I cannot speak too highly. In all our sad and sorrowful journey through Donegal in 1883 we were only asked for work, and the eagerness and earnestness with which schemes of industry were pressed on us was touching. All who have had anything to do with these simple people in times of distress will tell the same story. "Everywhere," in 1880, reports Mr. Fox to the Dublin Committee, "the people are clamouring for work, the women and children as well as the men, and force themselves on the baronial contractors in spite of them." Canon McShee speaks of the clamour of the people for employment, and says it is no exaggerated phrase that the people are "wild for work." Captain Gaskell, in his report to the Duchess of Marlborough's Fund gives the same account, and Mr. Marcus Ward, of Belfast, who went to Donegal in the winter of 1882 to organise relief works in Glencolunbkill, tells how piteously the people begged to be permitted to earn the 7s. a week allowed for the support of a family, and how well they worked. No one can, I think, also go through Donegal with seeing eyes and open mind, and not bear witness to the astonishing laboriousness of the people who, without capital and without help

of any kind, have turned stony wastes and barren bogs into arable farms and green fields. It is true John Bright said "Ireland is idle, therefore she starves;" but he did not forget to add, as most of his quoters have, that it was a "forced idleness." We, unlike the Austrian and German Governments, to whom the poorest mountaineer is an object of solicitude, and for whom industrial education and opportunities are provided free of cost, have neglected to recognise the fact that an agricultural population in small holdings have no occupation for the six winter months, and being isolated, have no means of obtaining it. Industrious as the Donegal peasantry are, we have failed in our duty to train them in the habits of continuous occupation, for habitual industry is as much a matter of educational discipline as learning arithmetic. The Irish children are allowed, in a great measure, to run wild,* and are not caught early, as the village children of Germany and Austria, to be disciplined by compulsory education, and trained in industrial work before they have entered their teens.

Their Refusal to be Pauperised.

Allied to this desire to live by work is their sturdy independence and dread of pauperism. I remember Mr Tuke telling me a story, in illustration of this trait, of a batch of tenant farmers and their families whom he was about to emigrate. As they had to be brought some distance, and could not be conveyed to the ship that evening, he had made arrangements that they should sleep in the empty wards of the workhouse. He was surprised to find great indignation expressed at this, and an absolute refusal to enter the workhouse. "No, they had kept themselves from that degradation, and they would not pass the last night in 'Ould Ireland' within the hated walls of the workhouse, even as guests." In Glencolumbkill the people remember with pride that the father and mother of President Johnson were emigrants from that village, and looking to America as the land of their deliverance, to enter which every young man man saves up his earnings, they argue from this precedent, "No one knows what we might not become in America; we will not, anyhow, have the brand of the pauper." The following dry figures gathered from the census returns of 1881 speak volumes for the character of the Donegal people. The records were taken in the midst of a cute and wide-prevailing distress. In the Letterkenny district, with a population of 15,571, there were 148 persons in the workhouse, and 2 receiving out-relief; in the Ballyshannon Union, with a population of 11,451, 133 persons were in the workhouse, and 12 receiving out-relief; in Donegal Union, with a population of 25,813, 124 were in the workhouse, and 82 receiving out-relief; in Glenties Union, population 37,551, 124 in the workhouse, 137 receiving out-relief; and in Strabane Union, population 12,943, nobody in the workhouse, and 13 persons receiving out-relief. I have only taken the Unions of the congested and famine-stricken districts.

* Education is not compulsory in Ireland.

Their Freedom from Crime.

As to crime in the same Unions, the police in the barracks scattered through the county have said to me over and over again, "These are a very inoffensive people," and the prosaic Blue-book says that on April 3rd, 1881, the period, it will be remembered, of great political excitement, in Donegal Bridewell there were three prisoners, in Letterkenny Bridewell one, and in her Majesty's Prison, Strabane, no prisoner. Of the helpfulness of these people to one another, I could tell you many touching stories; but the fact that though in 1881 there were 9,069 widows in Donegal, each probably with a large family, yet that there were in Letterkenny Orphanage but four orphans, tells how these people bear each others burdens. Their intelligence is striking, as well as their extraordinary deftness of fingers. Notwithstanding overcrowding, their chastity is irreproachable, and drunkenness, owing to the remarkable influence exercised by some of the parish priests, is almost extinct, the whole adult population of large districts being pledged total abstainers. Their courtesy of manner is charming, and their deep religious feeling, and belief in the watchful care of God, in these sceptical days, most refreshing. I may give a little instance illustrating some of these characteristics. Driving across one of the vast bogs of Donegal, one day in 1885, the horse of our car fell, and I was thrown out with much violence, and rather seriously hurt. My companion laid me on the turf bank while another car and horse were fetched, and being alarmed, she asked for whiskey for me of the few peasants that gathered around, but they had no whiskey, for, owing to the exertions of a good parish priest, who had died the year before, they were all teetotallers, but they brought me milk, and, with kindly courtesy, did all they could for my comfort. Presently, after a neighbour

had been fetched who had "more English," they discovered that my companion was Mrs. Power-Lalor, who had fed the children in the great distress two years previously; "But you are not hurt?" inquired the woman anxiously of her, "No," she answered, "not at all." "Ah, no," replied the woman with quiet assurance, "you couldn't be hurt in Donegal; the children pray for you."

The hopelessness of this county in 1883, the brave, patient attitude of the people in their deep distress, their earnest appeals for work, their forlornness, made a profound impression on my mind, and I do not speak the words of exaggeration when I say that I bore the sorrows of these people on my heart, and that the cry of their distress was never out of my ears day or night. Help them I must. I resolved to try the revival of cottage industries.

The Knitting Industry.

Knitting was the first industry taken up, and it is one in which I have spent and lost a considerable amount of money. The people may be said to have almost an inherited skill in knitting, and the industry is a very ancient one among them. So level and even is their work, that we have often difficulty in convincing people that the hosiery is actually hand-made; but alas! cheapness rules the market, irrespective of value, and the making of hand-knitted hosiery is, I am afraid, an industry which cannot be successfully worked to any large extent, that is to say, if an attempt be made to pay the workers a fair rate of wages. I have spent much time, money, and effort, in improving the finishing, dyeing, and patterns of hand-make socks. But the market for hand-knitted hosiery is limited and precarious, and the workers only too numerous, there being many thousands of skilful knitters in Donegal alone. Learning this by a sad experience, resulting in heavy losses, I have striven to utilise the women's skill in glove knitting of a superior kind, and I am glad to say that after a year spent in training the workers, a fairly good prospect of giving considerable employment is opening up in this direction. Let me not be misunderstood to claim to have invented glove and hosiery knitting as a cottage industry in Ireland. I have simply done something to revive it in some of the Donegal villages, to find new markets for the goods, and to improve the standard of work and the dyes. Many ladies, notably Miss Goold, Miss Roberts, the Duchess of Abercorn, and Lady Waterford, have worked in the same direction, and I wish also to say that it was observing the marked influence for good that the large knitting industry of the Messrs. McDevitt, of Glenties, had on the welfare of the people during the famine years of 1879-83, which first led me to see the value of cottage industries in Donegal. Glenties was the only Donegal village we visited where the cry of famine was not heard.

The Development of the Homespun Industry.

The cottage industry in which I have been enabled to bring about the greatest improvement, and whlch is full of promise for our future, is the weaving of artistic high-class homespun woollens. Noticing the stout grey homespuns worn by the men in the Donegal villages, and having the material occasionally offered me for sale by the people, I was led to consider if hand-spinning and weaving might not be developed into considerable industries, provided the people could be taught to make largely saleable products. Long, laborious, and costly has been the process by which the rough grey flannels, heretofore made in the outlying mountain districts of Donegal, have been developed into the beautiful homespuns now made under my direction, such as these which I now show you, and which are acknowledged in the trade to be unique. Patient and continuous instruction as to the methods, careful and minute superintendence of the processess of work, and an almost pitiless enforcement of orders on our part, and a willingness to learn and industrious effort on the part of the workers, have resulted at last in success. Instead of accepting the peasants' faulty work, the whole industry has been organised; the carding and spinning of the wool, the dyeing of the yarns, the warping of the webs, and the setting up of the looms for patterns, have been revolutionised, and many new processes introduced.

The plan I adopt is as follows:—I either buy wool from the peasant farmers of the district direct, or select it myself and send it in large quantities into Donegal. It is then stored in my village warehouses, and given out by weight on stated days to the carders, spinners, and dyers employed, all of whom are women. Minute instructions are given them as to the dyeing of the wool from bog plants, or from Indian vegetable dyes supplied, and as to the spinning of the weft and warp. At the end of a specified time the yarns are brought back

to the warehouse, checked, weighed, and examined, and the workers paid according to a fixed scale of wages. The webs are next warped by the weavers in the warehouse, and taken home to be set up in the looms in their own cottages, to be woven into cloth; regarding the pattern and colour of which exact instructions have been given by me beforehand. When ready, the webs are brought back to the warehouse to be critically examined by my agent. For careless faults in workmanship fines are exacted. If passed, the web is then sent in to the London depôt, 43, Wigmore-street. The full name and address of each spinner, weaver, and dyer employed is attached, and also a voucher for the sums of money paid in wages. The cloth is again examined yard by yard, generally by myself, and reported on to the village, each worker thus learning if his or her work has received my praise or blame. The other industries — knitting, embroidery, &c., are organised on a similar system. I am thus able to hold all the threads of the work in my own hands, know the names of, and can put my finger on all the workers, and can increase or diminish supply as demand requires. This careful and laborious superintendence of the departments and processes of the work, coupled with the technical instruction given, has revolutionised the industry in the short space of less than two years.

Plain weaving of undyed grey flannel in short lengths, to be sold to a traveller if he should chance to come that way, was all that the people could accomplish in the way of a trade in the Donegal villages three years ago; and as the yarn of these webs was too often carded and spun from day to day, or even from hour to hour as required, bars and inequalities of colour rendered Donegal flannel an unsaleable article among tailors, and gave it a bad reputation in the trade. Now all my homespuns are twilled. I have taught the people to find charming and permanent dyes in lichens and bog plants, and to combine colours in a manner that has made the homespuns of the Donegal Industrial Fund famous; and also to turn out webs of 50 yards in length, perfectly equal in colour and workmanship throughout. The whole of the work is done by hand in the cottages. Last year my workers made 10,000 yards of homespun cloth, which we sold for them; and within the next 12 months I anticipate being able to produce and find a market for ten times that amount. In expectation of large orders, I have, with the assistance of the Bishop of Raphoe and his parish priests, had a census made of all the spinners and weavers with wheels and looms in Donegal, and 3,500 spinners, and 140 weavers have given in their names as willing to work, and are anxiously awaiting training and employment.

The Need of Further Capital.

It needs now but the magic touch of capital to make this industry, already successfully started, a great one, to enable me to employ all these idle and willing-to-work hands, and thus help to banish famine from the shores of Donegal. The appliances with which this work is done are of the simplest; the yarn is mostly spun on the most primitive of wheels, which is turned with one hand while the thread is manipulated with the other, the woman running backwards 8 or 9 feet; the looms are what were old-fashioned 100 years ago, and have not even the flying shuttle. Further progress cannot be made by the best weavers without new looms, and I am glad to say that £100 towards providing my weavers with new looms has within the last few days been placed in my hands by a member of the family who have already generously supported this work by subscribing to the capital of the Donegal Industrial Fund—namely, that of Mr. Powell, of Guildford. With 56-inch wide looms, provided with the flying shuttle, we anticipate being able to weave travelling rugs, the demand for which is constant. Much more capital, however, is needed to develop this industry, both from its technical and commercial point of view.

Some Subsidiary Industries.

The other industries which I have assisted more or less are the hand-sewing of underlinen, initialing and embroidering of handkerchiefs, the old and almost extinct industry of sprigging, as well as lace-making, and crochet. I have opened a large depôt for the sale of our own products at Donegal-house, 43, Wigmore-street, and there all departments are represented. I have also striven and shall strive to make this depôt of value and use to Irish industries and Irish manufactures generally, by encouraging there the sale of Irish cloth, Irish poplins, Irish linens, and Irish lace.

Our Kells Embroideries.

I must speak now of another successful cottage, or rather, home industry I have been enabled to create—namely, that of the Kells embroidery, with several large specimens of

which this room is decorated. Destitute of business experience at the outset of my efforts, I thought in my ignorance of reviving the ancient industry of sprigging, or white embroidery on linen and cotton, in which Irish girls were once so famous. Investigation into the facts and experience of the markets proved this to be impossible. The industry is dead, killed outright by Swiss machine competition, and cannot be revived. Casting about, therefore, for some work that might employ the skilled embroiderers of Ireland, I hit upon the happy idea of using Irish flax threads on Irish linen cloths, to be worked in designs taken from the ancient Irish manuscripts. This constitutes the initial idea of the Kells embroideries. It has undergone subsequent developments, and in the curtains shown, which we have just executed to the order of the Queen for Windsor Castle, her Majesty having expressed a most kind desire to show her interest in my undertaking, you will see the interlacing and quaint Celtic devices are worked in silk in woollen cloth. The whole of these curtains are made by hand in Ireland, carded, spun, woven and embroidered by Irish hands; the design alone is by an English hand, Miss Aimée Carpenter, of Croydon, to whose happy genius for design our embroidery work owes much of its artistic success; but the inspiration is here drawn from an Irish source which, after 1,200 years, yields to England's and Ireland's Queen a motive for a curtain for her palace, in which piece of work are united English minds and Irish hands, Irish minds and English hands, giving and taking from one another as two sister nations should.

The Employment of Distressed Irish Ladies.

In the present terrible crisis in Irish history distress is not limited to the peasantry; many who have been well born, highly educated and tenderly nurtured, are suffering great privations, and the distresses of Irish ladies, whose piteous stories and appeals for work come before me every day, have touched my heart. These ladies I have been glad to employ in the Kells embroideries, and at the present moment about eighty distressed Irish ladies are provided with permanent remunerative employment. To show the boon the work is to them, I will quote from one or two of the numerous letters I receive almost daily.

A delicate lady, once well off, now supporting her sick husband and four children, writes, "I hope the work may please, and that you may be able to send me more soon, I am in great need, and will feel extremely glad if you can." A widow lady, supporting seven children, wrote, asking for work (which was given), saying, "It is hard indeed to have one's children hungry at Christmas." A young lady who, with her two sisters and mother, are supplied work, wrote, "You would be surprised, and pleased too, I know, to hear what an untold benefit your work is to me, and how it helps me in life." Another lady writes, "I cannot close this letter without expressing my grateful thanks to you for all your kindness in giving me such constant work during the past year, and trust you will continue the same; we shall need all the help you can give us." Another lady, living perforce on her own property, from which no income is now derived, writes, imploring that work may be continued, and says, "I have not even a penny to buy the stamp for this letter, but have to borrow one. Do send me more work; have pity on me." Another, a lady of title, whom we employ with her daughters, asks for prompt payment for work just sent, as "they have no money with which to buy food." And so on; it is difficult to make the selection. Such appeals come every day, and the gratitude so freely expressed leaves me often, as Wordsworth says, sadder than if I had received reproaches.

Our Village Technical Classes.

I have also started several village classes for the teaching of Kells embroidery, under the kind and watchful superintendence of resident ladies in parts of Ireland other than Donegal. The peasant girls show great quickness at picking up the stitches, and as they can earn good wages at the work, it is extremely popular.

I must speak for one moment of another industry which has just been successfully started at my suggestion, under the superintendence of Mrs. Cope, on her estate in County Antrim, namely, the spinning and weaving of linen by hand. This is likely to be eminently successful, as the demand for handspun linen for embroidery purposes exceeds the supply, and such linens have, with the exception of a small supply from Cumberland, to be hunted up from Russia, Norway, Portugal, and Germany.

I fancy I can hear still the weighty and sonorous *non possumus* pronounced by persons of business experience when first I enunciated my intention of reviving and developing the

manufacture of hand-made fabrics. "You cannot put back the clock;" "mills and machinery have crushed out hand-work." So they have, to a great extent. But there still remains a faithful few who have not bent the knee to the Baal of cheapness, to whom honest fabrics at a fair price have a charm, and who prize the individuality and character shown in careful hand-work.

Our Difficulties and Needs.

Thus far I have spoken only of our plan of work, and of the partial success with which it has been realised. I have said nothing of our difficulties. Aye, they would fill a volume to tell, and have been at times almost overwhelming; and if it had not been that with the Anglo-German instincts of my birth I never feel so unconquered as when thoroughly well beaten, and that my husband and a few sympathisers have again and again generously supplied the munitions of war with which to carry on this campaign against destitution, I should have been obliged to have laid down my arms long ago.* But the promised land is now in sight, and in my dreams I can hear proceeding from the cottages on the wild Donegal coast the hum of the spinning-wheel and the thud of the loom, and the merry clang of the hammer and the chisel, as other industries come to be added to those already revived, and instead of the ragged figures and famished faces that gathered, with pleading voices for work, around us in 1883, a well-clad, happy, and innocent people. Aye, the change is already begun, and last October when I went into Donegal to see and encourage my workers personally, and to give the spinners, dyers, and weavers who had won my commendation by their skilful and conscientious work, rewards in money, it was indeed cheering to note the marked difference in the aspect and bearing of the people employed, as they came crowding up to give me a hearty welcome, and to show me their work. Sometimes, when harassed by the enormous difficulties of my task, and rendered sleepless by its financial responsibilities, I am tempted to ask, why should I so burden my life, and rob it of peace, I recall a scene I shall never forget. A woman sits crouching in her rags by the embers of a peat fire, in a mud-floored cabin in a desolate part of the Donegal coast. No furniture is in the single room. On the bare bed built into a niche in the wall lies an emaciated child who we could see was fated soon to join his little brother who had died a few days previously of inanition, from insufficient food, or otherwise of starvation. The woman spoke not, nor moved, nor turned her head when we entered, she seemed unconscious of our presence. We spoke of the sick child, pitied her poverty, and put money into her hand, but she heeded us not; she sat there silently, apathetically gazing into the fire—the very type of a nation's despair. It is from this I would save the people, and to do which I look to you for help.

* My husband has given me nearly £4,000 towards our capital; Mr. Powell and his daughters, £800; Rev. S. A. and Mrs. Barnett, of Whitechapel, £200; and Miss Hume, of Edinburgh, £100.

Our Prospects.

We are but on the threshold of our work; we have made a little impression, we have proved that the thing can be done, that the people will work, and that the goods can be sold, but the enterprise is too vast, and the difficulties too great for volunteer effort to accomplish alone. State aid must be given, as it has been given in other countries under similar circumstances. Without improved methods of transit and without technical education, all our efforts are in vain, and the little good we can do will die with our own lives.

The Question of Transit.

To take the question of transit first. To speak only from my own experience. My nearest centre of industry is forty miles from Derry, and from this city all raw materials and all worked up goods have to be carted at a cost of 3s. 6d. a cwt., the higher tariff of the branch line to Letterkenny making cartage for this long distance actually cheaper than using the rail part of the way. To carry goods from London to Gweedore costs £6 a ton, a really prohibitive tax on manufactures. I have attempted to send my bales by sea, the cost being much less, by a small coasting steamer plying between Liverpool and Sligo, but as there is no harbour into which the steamer can run (Bunberg being impracticable) the bales have to be delivered in the open sea under the shelter of Gola Island. A few months ago I sent 1,500 lbs. of wool by this steamer, but three weeks passed before it could be landed, though twice a week as the steamer went by my anxious workers went out in boats to bring in the bales, but so rough was the sea and so dangerous is the coast that the steamer had to stand far out to sea, and my poor people were week after

week disappointed. Representations have been made over and over again to those in power and authority of the pressing need of a quay between Bloody Foreland and Bunbeg Point, or at Burton port. The cost would be under £5,000, and the benefit to the development of the fishing industries, which are now *nil*, though the sea is full of fish, and large lobsters and crabs can be bought for a few pence, would be incalculable, as well as to the local industries of the country; to say nothing of the possibilities then given of working the marble, granite, glass-sand, and bog-ore with which the country abounds. But our representations fall on deaf ears. No one denies the need. Writing to me on this subject a short time since, Sir Thomas Brady says: "As to developing the fisheries on the west and north-west coasts it cannot be done till proper harbours are provided for proper vessels, and railway accommodation afforded, and until this is done poverty will exist, and all your exertions will be labour in vain." Quays or harbours, however, will be useless without tramways or narrow gauge railways to carry the goods at cheap rates to the great central lines; but as long as the cost of construction of these must be borne by the county cess nothing will be done, for it is obviously impossible for a destitute and starving country to pay the costs of such an undertaking. But surely we may ask that if for the military defence of the empire, and the retrieval of its honour, it was thought well to spend millions of money on a railway in the deserts of the Soudan leading to nowhere, a few thousands might be expended in saving our own people from the cruel ravages of starvation, and ourselves from the dishonour of having in our midst a people whose condition is a disgrace to humanity. For our Indian subjects we have done this, why not for Ireland?

Village Technical Classes for the Peasants.

To turn to the other great question of technical education, it is apparent that to have succeeded in training my workers to make dyed homespuns such as these shown, it has been necessary to give them a large amount of technical teaching. How to obtain the necessary information myself, and how to impart it to others, was the difficulty. I am frequently asked how I learnt the little I know of textile arts. It was simply accomplished by a laborious and lengthy process of picking up scraps of knowledge in books, shops, and factories; for on applying to the accepted authorities to know if I could not practically learn the technical arts of dyeing and weaving in London, I was told "No, I should have to go to Leeds." Thus, in this vast London, with its 5,000,000 of inhabitants, its Technical Guilds Institute, its Science and Art Department, its City Companies, neither I nor any one else can learn dyeing and weaving. In Austria I could have been practically and well taught in twenty-two schools. If so difficult to learn, how much more difficult to teach? This was accomplished almost entirely by correspondence. My workers are gathered together, and my letters are translated into Irish, and read aloud — for few of them "have any English"—and experimental work is begun and carried on, according to my instructions, under the active superintendence of my intelligent and indefatigable agent, a Donegal man. Clumsy as have been the methods, and slow the results, enough has been accomplished to demonstrate beyond dispute that if small classes could be founded in the Donegal villages for teaching technical arts, such as dyeing, weaving, glove making, marble cutting, basket weaving, netting of fishing nets, wood carving, pillow-lace making, and boot making, and practical instruction given in butter making, fowl keeping and fish curing, manufacturers would soon find out that there was an abundance of cheap skilled labour near at hand, and orders would be transferred to Ireland that now go to Germany and Switzerland, and an absolute revolution would thereby be created in the condition of the people. Without subsidiary industries the people cannot exist as an agricultural people, they must either die out or be driven out. In forty years the population of Donegal has diminished 90,000; in the last ten years it has decreased by 12,000. The young and strong are emigrating; leaving the old and weak behind, and I, for one, must say that I should deeply regret to see the extinction of such a hardy, industrious, virtuous, and independent race as the Donegal peasantry, and think it would be a national disaster.

The Village System of Teaching in the Erze-Gebirge.

The plan that I would propose for the cultivation of cottage industries is very simple and economical, and is similar to that which I have seen worked with such advantage to the people in the mountain districts of Bohemia. In Prague

a committee, composed of volunteers—the president and founder being the veteran Ritter von Dotzauer—and of Government nominees, was founded about fifteen years ago, to watch over and encourage the village and hand industries of the Erze-gebirge and Riesen-gebirge. The Government gives from time to time a large grant of funds, and reports have, at stated intervals, to be made to it of all proceedings and proposals. The work of this committee is eminently watchful and initiatory. Classes of instruction are started in the mountain villages, the ordinary instruction of the people is supplemented when necessary, and new industries started where required. I will give examples. Finding that one of the mountain villages was without a local industry, it was thought advisable to introduce that of the rearing of canary singing birds. An intelligent person was therefore dispatched to the districts where this was already done, to learn the methods adopted. The people were then instructed by the Prague Committee, the birds were introduced, and the industry proved of extraordinary lucrativeness to the village. When last in Derry, I heard that there had been an immense consignment of these very canaries, and that they had been quickly distributed through the country. In another village, where the making of musical instruments was the local industry, it was considered that the cause of imperfection in the making of the instruments was due to the fact that the village artisans knew nothing of harmony. Music classes were, therefore, started by this wise and watchful committee, and soon the better understanding of the principles of harmony led to such a marked improvement in the making of the instruments, that a large and steady demand for them was created. We made a special investigation into the methods of teaching lace making practised by this committee, making several long excursions into distant mountain villages to see their lace classes, our object being to obtain information how to revive the decaying lace industry of Ireland. The methods adopted are as follows :—A class is opened for children, who attend as half-timers, elementary education being compulsory. The committee pay the teachers, and the municipality supply the room. The children bring their own materials, and are allowed to sell what they make. When a class has given evidence of permanent vitality by existing and attracting students for five years, the Government takes over its whole charge, and the committee is then free to use its funds to found another. I was so struck by the economical, practical, and sagacious work of this committee, and so impressed by the value of its influence on village industries, that I entered into a long correspondence with Lady Aberdeen, on whose council for the promotion of Irish industries, founded last year, I was, by her request, one of the earliest members, and urged on her the adoption of some such plan as the basis of her new organisation, and begged her to make her large and influential committee of use in aiding and developing village industries by giving technical instruction, instead of adding another to the many struggling bodies and individuals who are trying to give out knitting and sewing in Ireland, and to sell the products. Lady Aberdeen went to India before the matter could be threshed out, and as the council has not, I believe, been called together, I have not yet had an opportunity of laying these views before it. But I hope that on Lady Aberdeen's return from India, the matter will be fully discussed in council, and that this great opportunity of initiating some such scheme of village technical education as that adopted by the Prague Committee will not be lost. To complete the description, I must tell you that the Prague Committee have also a school for teachers in Vienna, and that, in return for their education, these students are bound to go back to their native villages to teach. This school is in connection with the Government school of design. Thus we see that by this system of connecting schools, the treasures of the national museums and of the schools of design, and also the latest fashions, are passed on to, and are practically turned to account by, the poorest lace-worker in the most distant and inaccessible mountain village. We found enormous orders being placed for the English market, and I could but think sadly of the skilful Irish lace workers who, for the want of practical teaching carried to her door, is, in spite of Mr. Alan Cole's excellent efforts to provide her with designs, still making and trying in vain to sell, the same designs and patterns taught by kindly ladies out of pity in the time of the great famine. Impressed by the simplicity and economy of the Austrian methods, Mr. Hart, on his return, wrote to the Chief Secretary for Ireland on the subject, calling his attention to the importance of such an organisation, and offering to guarantee or provide a sum equal, in each village of Donegal, to any Government outlay on village technical teaching. The lace-making I was prepared to have taught in these classes was

a new kind of torchon lace, in the production of which I have introduced the improvement of working in coloured flax threads, and which, in order to keep in the hands of my workers, I have protected, in their interest, by a patent. All was ready to found a new industry, but we felt that State aid, from the educational point of view, was all-important. The Chief Secretary's reply was disappointing; he replied he was too much engaged in political work to give the matter consideration. But lace is only one of the many village and cottage industries cultivated in and around the Erze-gebirge, and which is stimulated and developed by an elaborate system of State-aided technical education. Everywhere, on the plains, up the beautiful mountain valleys, beside the torrents, the water of which is used to turn numerous turbines and wheels, in the lovely pine forests stand the factories and workshops for porcelain, pottery, glass, embroidery, wood-paper, &c., and in every cottage and every room are found one or more busy workers. Often and often have I compared the people of these industrial villages, as I met groups of laughing girls coming home in the evening along the lanes, or saw the workmen trudging through the forests on a Saturday afternoon to their mountain homes, and heard in the evening issuing from the cottages the sound of the harmonium, the zither, and the cornet—often have I compared their lot to that of my poor Donegal peasants; for the original conditions of life of the Bohemian and the Donegal peasants are almost identical, with the exception that the houses of the former are freehold. There is the same isolation, forests instead of bogs separate them from civilisation; they live in mountain villages that might have been congested, but are now industrial; they partly support themselves by agriculture, the plots of mountain land being however, insufficient to support life; the rate of wages, the food, the life, the habits, and the opinions of the people are strangely alike, and if the Bohemian villagers, had not been helped, cared for, and educated, they would have sunk as low as the peasants of Donegal. But surely what Austria has done for her people we may do, and Ireland has more than an ordinary claim on us.

I have told you the story of my work, how the experiment was attempted, how much has been accomplished, and what remains still to do; and I appeal with earnestness to all who have heard this story, to aid me to carry out this scheme big with promises of hope, happiness, and comfort, to a despairing people. The task is vast, but by faith in one another we may remove mountains. In the great storm which swept over Donegal on 1st October, 1881, devastating crops and ruining houses, two girls, living with a decrepid father, ran to the mountain side of Slieve League, and brought down huge stones to place on their little stack of hay to prevent it being blown away, Afterwards, on being asked how they had managed to lift stones and rocks weighing at least 150 lbs. each, they replied simply, "We did it with our strength; God helped us." This task we must also do with our whole strength, working together, and God will help us to bring the sunshine of self-reliant prosperity to a most unhappy country.

DISCUSSION.

The CHAIRMAN said it had given him the greatest possible pleasure to preside over that meeting. He had had the honour of knowing Mrs. Hart for some years, and could therefore speak of the efforts which she had been making for the good of her fellow creatures, by founding the Donegal Industrial Fund, for the development of cottage industries in Ireland. The paper to which they had listened had hardly been surpassed in interest by any which had been read before the Society of Arts. He had seen Mrs. Hart commence the work, and having followed her through it, he knew the efforts she had made, and with what anxiety she had made them. They must all be aware that Mrs. Hart was no ordinary person, but a woman with an immense amount of intelligence and education, who was qualified to act as a physician; having passed all the necessary examinations, the results of her work had been shown in the exhibitions lately held at South Kensington, and Mrs. Hart had had the satisfaction of receiving a gold medal for them. This reward was not only well merited at the time, but would have been much more merited now. It was the bounden duty of everyone to do all they possibly could to support this scheme, which was actually saving the lives of many poor people in Ireland. What was wanted was assistance in the shape of capital, and he hoped that this would be provided. The matter was one which touched very closely the Society. They had been told how many of their fellow creatures were in a starving condition, and how with a small capital the work could be made profitable, and how much assistance was required. He could not help feeling that if it were possible to get the paper circulated, and read by those who had constantly on their lips the Irish question, if instead of passing nights and days in squabbling over words and lines of a legislative measure, they were to spend an hour in reading this paper, something of a practical nature would be done. He

trusted that the paper would be repeated in London over and over again, and also in some of the large centres of the United Kingdom. He knew that the press was ever ready to promote such schemes as had been proposed that evening, and he had not the slightest doubt that they would do all they could to advance the cause.

Mr. ERNEST HART said he looked more to the future than to the past in this matter. He had had some difficulties, and had borne some losses, as he had invested or advanced capital to carry out the work, for of course in such an enterprise capital might be said to be advanced rather than invested, it being a patriotic object which was aimed at. In the first instance, they were quite content to bear losses, and had advanced capital to the extent of between £4,000 and £5,000. These losses belonged to the initial period of the enterprise; they had now been wiped off. The fund was now, he was pleased to say, in a stable condition. The whole of the balance-sheets had been audited from the first by public auditors, and the balance-sheet for the last six months showed a small per-centage of profit on the capital invested. This was very encouraging, but they must not assume it meant more than every commercial man understood. Four per cent. was not a commercial profit, and no doubt, as the enterprise developed, some expense would have to be incurred for management, which hitherto had not been the case. At the present moment the measure did not offer any temptation to the cupidity of capitalists, but he believed the affair was in a perfectly sound condition. Many of the great commercial men of the country had stated that it was impossible to revive the cottage industries of Ireland, but this had proved not to be the case, because no doubt there was a market for every kind of quality and merit wherever work of an artistic character was produced. The cottage industries of Ireland had failed because the people had been without technical training; their artistic capacities had not been developed. England had not done for these people what the Government of Bohemia and the small traders of Prague and Pesth had done for the villagers there. Landlords and landowners had not been resident in Ireland. Had they been, it would be impossible to suppose that they would not have done for their neighbours that which the landlords and residents of Belgium and Austria had done for their mountain villagers. He did not impute blame to individuals, he rather pointed to a condition of things connected with the political state of Ireland, and he thought it was the absolute duty of all who had any interest in Ireland to make some effort to extend and develop its industrial resources. The Irish peasants had shown themselves capable of receiving technical and artistic instruction, and of manufacturing products which had received the artistic commendation of the most critical persons, and now found a relatively large market in the homes of the upper classes both on this and the other side of the Atlantic. The Irish peasants had shown themselves capable of producing homespun and tweeds which the most critical traders of Glasgow and Bradford declared to be in every respect equal to, and in some cases superior to, the best Scotch homespun. This work had been achieved unaided by a woman who had no technical knowledge, and who had at her command only the small capital which he had been able to advance for this charitable work. Having overcome the initial difficulty, and brought the enterprise to a condition of some stability and promise, he hoped that his wife was not asking for too much when she asked for the sympathy, interest, and aid of her audience.

Mr. MARTIN WOOD thought the main question was how the wonderful example of Mrs. Hart could be turned to greater account, multiplied and extended. What had been done in Donegal could no doubt be done in Kerry and other districts by the same means. He had been particularly struck with the way in which Mrs. Hart had shown that the necessary dyes could be produced from the Irish bog plants. The question was one of capital, and he had no doubt the requisite funds would be provided. He was very pleased to notice the excellent character which had been given by Mrs. Hart of the Irish peasants.

Miss SHARMAN CRAWFORD said, the people in the south of Ireland had the same qualities as those in Donegal. The great want was technical instruction, and she thought it most desirable that this matter should be pressed on the Government, because individuals could not do this unaided. The Government should expend money in providing cheap means of communication, because in Kerry the difficulty of transport was a serious obstacle. Commercial success depended upon this being attended to. With regard to fisheries, she thought it was most necessary that piers should be built. It was important that pressure should be brought to bear on Government in this matter, as it was of most vital necessity to the success of Irish industries.

Mr. STORR thought the importance and absolute necessity of making this paper more widely known could not be over estimated, believing that it would be a perfect revelation if the paper were read by the majority of the members of Parliament, as to what ought to be done for the prosperity of the Irish people. The paper seemed to touch upon almost every point of importance which had come before Parliament during the last twenty years. There were many persons so much absorbed with the political side of the Irish question that they really had no notion of what might be done for improving the Irish peasants, and if it were put before them in the clear way in which it had been brought before that meeting, he thought that Parliament would look at Irish matters in a very different light to what it at present

did. A few days ago he heard a member of Parliament say that the difficulty of dealing with Irish questions arose from the fact that the people of Ireland were actuated by an undying hatred towards England; but he thought this statement was disproved by what they had just heard, that the people in Donegal had expressed their unbounded gratitude for the efforts made to improve their condition. If more was done in this direction, it would go a very long way towards cementing the bond of union between Ireland and England.

The CHAIRMAN said that there was really no room for discussion, as everybody unanimously approved of the objects of the paper. Knowing very well the interest which Lord and Lady Spencer had taken in Irish matters for many years past, he congratulated the audience, and Mrs. Hart in particular, upon the fact that the Countess Spencer was present that evening. He begged to propose a hearty vote of thanks to Mrs. Hart for her able and interesting paper.

The vote of thanks was then carried.

Miscellaneous.

COLONIAL AND INDIAN EXHIBITION.

The Royal Commission appointed by the Queen for the purpose of organising and carrying out the above Exhibition met for the last time on Saturday, the 30th April, at Marlborough House, under the presidency of the Prince of Wales.

A statement of receipts and payments in respect of the Exhibition, from 18th November, 1884, to 23rd April, 1887, with an approximate balance-sheet, was adopted at the meeting, showing that the total receipts were £249,861. The admissions for the opening ceremony are credited with £2,659, and other admissions £203,181. The royalties paid by refreshment contractors and others amounted to £22,250, and £2,000 was paid for the concession for publishing the catalogue and other official publications. Advertisements yielded £1,387; the cloak-room and lift at the Albert Hall, £1,267; the sale of programmes, £324; hire of bath chairs, £338; and sale of screens and Indian exhibits, £4,437. The Colonies and India contributed £2,001 towards the buildings and fittings, and £1,128 was paid for the maintenance of the natives. The Society of Arts paid £385 for the use of the Exhibition for its conversazione. When sold at the close of the Exhibition the buildings and plant produced £7,223. The total payments amounted to £215,218, showing surplus receipts £34,642, to which is added, as an asset, £419 for purchase of Indian screens for the Imperial Institute, and other items, raising the total surplus to £36,405. The sum expended on buildings taken over from the Inventions Exhibitions and on new buildings was £36,228; and £2,376 was paid for the garden seats, &c., taken over from the previous exhibition. The amount paid for rent to the Exhibition Committee of 1851 was £5,075, to the Royal Albert Hall Corporation, £7,845; and to the Fisheries Exhibition, 1883, £4,833. The rates and taxes amounted to £5,826, the electric lighting (exclusive of the gardens) cost £19,335, the motive power for machinery exhibits £3,350, gas £2,222, water £1,152, and insurance £1,685. Salaries and honoraria are set down at £14,070, and they include £3,986 for the assistant secretary, accountants, and general staff; £3,936 for the assistant secretary and staff for India; £675 for general superintendents, £964 for superintendents and assistants in the Indian Court, £348 for the admission department, £1,680 for the City and official agent's office, £500 to Sir P. Cunliffe-Owen, as Secretary to the Royal Commission, beyond his salary as Director of the South Kensington Museum, and £1,459 honoraria to forty-six of the staff for exceptional services and nightwork. The wages of sweepers, gate-keepers, police, fire-brigade, watchmen, bath chairmen, &c., amounted to £24,037. Other items are as follows:—Postage, telegrams, and telephones, £753; travelling expenses, £1,075; office and incidental expenses, £834; printing and stationery, £4,070; solicitors' costs, £1,014; auditors' fees, £1,100; editing official catalogue and special Indian catalogue, £1,330; printing 260,000 copies of railway guide for gratuitous distribution, £2,614; advertisements in newspapers, £2,382; placards, £7,765; a million circulars, £1,268; reception and delivery of exhibits, £3,651; and commemorative medals and diplomas, £2,569. The expenses of the opening ceremony were £1,909, and included £979 for the erection of stands, &c., £87 for floral and other decorations, £413 for military bands, and £429 for printing programmes and tickets. Music during the whole time of the Exhibition cost £12,856, including £10,871 for military bands, £1,186 for the West Indian band, and £654 for organ recitals and concerts. The floral decorations in the gardens and conservatory cost £1,839; the illumination of the gardens, £10,673; the illuminated fountains, £2,779; the aquarium, £2,960; compensation for personal injuries, £225; conferences and lectures, £332; picture-gallery expenses, £508; the emigration office, £76; the artisans' and children's admission schemes, £2,131; purchases for the Indian Court, £6,481; other expenses on the Indian Courts, £7,660; and the maintenance of natives, £1,128.

It was resolved that £5,964 11s. 3d. be granted to defray the deficit on the Inventions Exhibition. A sum of £25,000 out of the surplus was granted to the Imperial Institute, and the balance

of £4,270 16s. 3d. was ordered to be invested in the names of Sir Edward Birkbeck, Chairman of the Executive Committee of the International Fisheries Exhibition; the Duke of Buckingham and Chandos, Chairman of the Executive Council of the International Health Exhibition; Sir Frederick Bramwell, Chairman of the Executive Council of the International Inventions Exhibition; and Sir John Rose, Chairman of the Finance Committee of the Royal Commission for the Colonial and Indian Exhibition, to hold in trust as a reserve fund to meet any unforseen contingencies in connection with the series of Exhibitions. Within a period of six years this sum, or the balance of it, will be paid over to the Imperial Institute.

PRODUCTION OF PITA FIBRE IN HONDURAS.

Consul Burchard, of Ruatan, says that the pita plant, called "silk grass," belongs to the same order as the pine-apple. It has never been cultivated, but is found growing spontaneously in the vicinity of the sea coast, on the margins of rivers and lagoons, and also on the highlands below an altitude of 2,000 feet. It is very abundant and prolific, and it grows in patches of various dimensions, some of which contain not less than a hundred acres. When it takes possession of the soil it spreads rapidly, and kills all other vegetables except large trees. Each plant or sucker has from thirty to fifty stalks, which measure from five to twelve feet each in height, and from two to three inches in breadth. The fibre is contained in the centre of the stalk, in filaments running through its entire length. The outside bark covering the fibre is very hard and tenacious. The following is the method employed in extracting the fibre. The Indians place each stalk upon an oval slab, and scrape off the bark which covers the filaments with the sharp edge of a split bamboo. This is a slow and laborious process, which yields on an average not more than one pound of clean fibre a day to each man or woman. The Caribs keep the stalks in water until the bark becomes partially decomposed, when it can be rubbed off quite easily, but the process is said to injure the strength of the fibre. In recent years many attempts have been made by foreigners to extract the pita fibre mechanically, variety of machines having been invented for that purpose. Grants of territory and exclusive privileges have been obtained from the Government of Honduras to work the pita fields, and large sums have been expended in erecting machinery and other preparatory works. In every instance such attempts have failed, owing entirely to the fact that no machine or process has yet been invented that will extract the fibre from the pita plant on a scale sufficiently large to make it profitable. In Honduras the pita fibre is in general use for thread, especially for sewing boots and shoes, for nets, fish-lines, halters, and the best quality of cordage. Samples of this fibre, Consul Burchard says, have been sent to the United States and to Europe, which have been manufactured into a variety of articles such as handkerchiefs, laces, ribbons, wigs, false hair, &c. It is claimed that it can be successfully employed as a substitute for either silk or linen. The fibre is sold by the Indians in the backwoods, prepared in rolls or skeins of about twelve inches each, at a cost of about one shilling the roll. In the cities and towns of the interior it is sold in small quantities to shoemakers and others for about four shillings per pound. Consul Burchard, in conclusion, says "The cost of preparing pita fibre for market by the native system is too great, and the quantity prepared too small for it to become an article of export. With suitable machinery thousands of tons could be extracted from the wild pita fields of Honduras, and when these are exhausted, it could be cultivated with the greatest facility. There can be no doubt that this valuable fibre is destined to become a very important element in the future commerce and industry of this country."

CULTIVATION OF SUGAR IN SALVADOR.

Consul Duke, of San Salvador, says that the sugar-cane is among the chief objects of culture in the Republic of Salvador. The export of raw sugar is a source of considerable wealth to the country, ranking third among the articles of commercial importance. The sugar-cane grows best on wide, open, unbroken plains, that offer no impediments to an efficient use of the plough. The soil most favourable to its production is a rich heavy black loam, light soils containing sand or gravel being avoided. The use of natural or artificial fertilisers is almost totally unknown among agriculturists of Salvador; the only artificial means used to recuperate the soil are to burn all the weeds and refuse on the fields, and to spread the wood ashes from the furnaces, the refuse from the filter presses, and the skimmings and settlings from the juice treated with lime. Land can be purchased at such nominal prices that renting is very unusual, except among the labouring classes. The price differs according to the population of the district; the average being about 12s. 6d. per *manzana*, the *manzana* being equivalent to 100 yards. Sometimes the rent is paid in labour. Labour is usually plentiful, although when the maize is planted in May and November, a scarcity is felt. The labourers work by the piece, their tasks being measured out to them; reapers are expected to cut three cartloads of cane of a given weight per day, and the cartmen to deliver four cartloads at the mill daily. The tools used are of the simplest and most primitive description. The machête is the invariable tool as well as weapon of every labourer;

it is used to cut down the cane and to clear the ground from brushwood and weeds. In addition to the machête, the hoe and native wooden plough are used, while in some of the larger plantations the American plough is to be found. The machinery erected in the large sugar manufactories in the country is of the finest English or German make with all the latest improvements The native mills are of wood, worked by oxen. The juice extracted is boiled over open fires until it granulates. There are no fixed hours for work, as the labourer is paid by the piece or task. He begins early or late as he chooses, provided his task be efficiently carried out; he then receives about one shilling, and his food twice a day. Mill hands work by the day of twelve to fourteen hours, and are paid according to their skill; if they are required for night-work they generally receive double pay and an extra meal. Like the field hands, they receive their food, which costs the planter about 3d. each man. Directly the rainy season is over in November and December the cane planting begins. After ploughing the land two or three times furrows are made about 15 or 18 inches deep and two yards apart, into which cuttings of cane are laid lengthways, and then covered over with soil. The cane sprouts very quickly, and about March the field is cleared and weeded. In May the plough is used between the furrows, and the final cleaning and weeding takes place in July, after which it is not touched until the following January, when the cane is quite ripe. The ploughing of a *manzana* in May costs about 6s., and the final cleaning in July from 8s. to 16s. When it is once planted sugar-cane yields from five to eight crops before it is exhausted, and where the crop is very rich it has been known to yield from eighteen to twenty crops. A *manzana* is estimated to produce about 1,500 quintals of cane, yielding from 9 to 10 per cent. of sugar.

Correspondence.

VILLAGE COMMUNITIES IN INDIA.

In connection with Mr. Hewitt's interesting paper, read before the Indian Section, I should like to draw attention to a valuable pamphlet, published at Calcutta, in 1873, and entitled, "Papers regarding the Village and Rural Indigenous Agency employed in taking the Bengal Census of 1872." In the Lieut.-Governor's instructions to the Commissioners occur the following directions: — "In addition to the enumeration of the various indigenous agents employed, the Lieut.-Governor wishes that you and your district officers should explain fully and clearly who the various village notables or officials mentioned are, *e.g.*, in the case of village headmen, mundals, mukleyas, pardhans, or by whatever name they are known, it should be explained what is the origin, history, and present state of these village heads." The pamphlet contains an abstract of the particulars thus obtained, and is therefore a very remarkable document, as showing the existing condition of the village communities in Bengal.

H. B. WHEATLEY.

General Notes.

SIBERIAN EXHIBITION, 1887.—It is arranged that a Scientific and Industrial Exhibition of Siberia and the Ural shall be held at Ekaterinburg in July and the first half of August next. The Exhibition is organised by the Uralian Society of Natural Science, and is divided into nine sections, including natural history, anthropology and archæology, mining, manufactures, domestic industries, fine arts, &c.

THE LATE SAMUEL COUSINS, R.A.—Mr. Louis Fagan, writing in the *Times* of the 10th inst., quotes the following announcement from the *Freeman's Exeter Flying Post*, June 3, 1813:—"We are happy to hear that Samuel Cousins, a poor boy of twelve years of age, belonging to one of the charity schools in this city, has been rewarded with a silver palette by the Royal Society of Arts in London, for his ingenuity in the execution of an admirable penci drawing of the portrait of Ben Jonson." The actual terms of the award were:—"To Samuel Cousins, St. Mary-steps, Exeter, for a drawing of Ben Jonson, a copy. The silver palette." In the same year awards were made by the Society to Master (afterwards Sir) William Ross, R.A., miniature painter, and to Master (afterwards Sir) Edwin Landseer, R.A.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MAY 18.—"Progress in Telegraphy." By WILLIAM HENRY PREECE, F.R.S. SIR FREDERICK BRAMWELL, D.C.L., F.R.S., will preside.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MAY 27.—"Indian Tea." By DR. T. BERRY WHITE. H. S. KING, M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE. PROF. HUBERT HERKOMER, A.R.A., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 17.—"The West Indies at the Colonial and Indian Exhibition." By SIR AUGUSTUS ADDERLEY, K.C.M.G. SIR RAWSON RAWSON, K.C.M.G., C.B., will preside.

CANTOR LECTURES.

The Fifth and Concluding Course will be on "The Chemistry of Substances taking part in Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

LECTURE III.—MAY 16.—Methods of retarding and preventing putrefaction.—Physical conditions least favourable to putrefaction.—General classification of chemical methods adopted for the prevention of putrefaction.

LECTURE IV.—MAY 23.—Special consideration of the chemical substances employed.—Antiseptics.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. M. Thomson, "The Chemistry of Substances taking part in Putrefaction and Antisepsis." (Lecture III.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. C. R. A. Wright, "Note on the Action of Zinc Chloride on Castor Oil." 2. Mr. John Ruffle, "New Method of Estimating Moisture in Superphosphates and Similar Fertilisers." 3. Mr. A. Wingham, "Further Notes on English-grown Tobacco."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. President's Inaugural Address. 2. Mr. Francis R. F. Brown, "The Construction of Canadian Locomotives." 3. Major Thomas English, "Experiments on the Distribution of Heat in a Stationary Steam-engine." 4. Mr. John Richards, "Irrigating Machinery on the Pacific Coast."

Asiatic, 22, Albemarle-street, W., 4 p.m. Annual Meeting.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m.

Anglo-Jewish Historical Exhibitions, Royal Albert-hall, Kensington, S.W., 8½ p.m. Rev. Francis L. Cohen, "Rise and Development of Synagogue Music." With musical illustrations by choir and organ.

TUESDAY, MAY 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Augustus Adderley, "The West Indies at the Colonial and Indian Exhibition."

Royal Institution, Albemarle-street, W., 5 p.m. Prof. Victor Horsley, "The Modern Physiology of the Brain, and its Relation to the Mind." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Sir Lowthian Bell, "The Manufacture of Salt near Middlesbrough."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Charles Booth, "The Inhabitants of the Tower Hamlets (School Board Division), their Condition, and Occupations."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Mechanical Engineers, 25, Great George-street-S.W., 7½ p.m. Reading of papers, and discussions continued.

Zoological, 11, Hanover-square, W., 8½ p m. 1. Mr. W. F. Kirby, "A Revision of the Subfamily *Libellulinæ*, with Descriptions of new Genera and Species." 2. Mr. R. Bowdler Sharpe, "Notes on the Hume Collection of Birds." (Part III.) 3. Mr. A. Smith-Woodward, "The Presence of a Canal-system, evidently Sensory, in the Shields of Pteraspidian Fishes."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Mr. J. F. J. Sykes, "Nature of Nuisances, including Nuisances the Abatement of which is Difficult."

WEDNESDAY, MAY 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Henry Preece, "Progress in Telegraphy."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. H. Sharpe, "Brocken Spectres and the Bows that often accompany them." 2. Mr. William Marriott, "Results of Thermometrical Obvervations made at 4,170 and 260 feet above the ground, at Boston, Lincolnshire, 1882-86." 3. Mr. E. J. Lowe, "Snow Storm of March 14th and 15th, 1887, at Shirenewton Hall, near Chepstow."

Pharmaceutical, 17, Bloomsbury-square, W C., 11 a.m. Annual Meeting.

Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Summer Exhibition.

Archæological Association, 32, Sackville-street, W., 8 p.m.

United Service Inst., Whitehall-yard, S.W., 3 p.m. Commander Charles Campbell, "The Interior Economy of a Large Fleet."

THURSDAY, MAY 19...Chemical, Burlington-house, W., 8 p.m. 1. Messrs. R. Wyndham R. Dunstan and T. S. Dymond, "The Formation of Hyponitrites." 2. Messrs. W. A. Shenstone and J. T. Cundall, "Ozone from Pure Oxygen." 3. Mr. S. U. Pickering, "Thermal Results of Neutralisation and their Bearing on the Nature of Solution, and the Theory of Residual Valency." 4. Professor Purdie, "The Action of Metallic Alkglates on Mixtures of Thermal Salts and Alcohols."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Louis Fagan, "The Art of Engraving on Metal Plates from its Origin to the commencement of the Sixteenth Century."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. Major Lamerock Flower, "The River Lea."

Royal Institution, Albemarle-street, W., 3 p m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture V.)

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

FRIDAY, MAY 20...United Service Inst., Whitehall-yard, 3 p.m. Colonel Lonsdale Hale and Major C. F. Beresford, "Tactics, as effected by Field Telegraphy."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. B. Baker, "Bridging the Firth of Forth."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Dr. Charles Kelly, "Sanitary Law—General Enactment—Public Health Act, 1875—Model Bye-Laws."

Philological, University College, W.C., 8 p.m. Anniversary. Paper by the President, the Rev. A. H. Sayce.

SATURDAY, MAY 21...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor John Hales, "Victorian Literature." (Lecture II.)

Journal of the Society of Arts.

No. 1,800. Vol. XXXV.

FRIDAY, MAY 20, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 15th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each. Not more than four tickets will be sold to any one member, and not more than 2,000 in all. When 2,000 have been disposed of, the issue will be stopped.

Tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter, a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, &c.) will be supplied. No refreshments can be obtained by purchase.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient. The members' invitations will be issued shortly. Visitors' tickets can be purchased from the present date.

Further particulars as to the arrangements will be announced in future numbers of the *Journal.*

CANTOR LECTURES.

The third lecture of the fifth and concluding course of Cantor Lectures on "The Chemistry of Substances," was delivered by Mr. J. M. Thomson, F.C.S., on Monday evening, 16th inst.

The lectures will be printed in the *Journal* during the summer recess.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 17th, 1887; Sir Rawson Rawson, K.C.M.G., C.B., in the chair.

The paper read was "The West Indies at the Colonial and Indian Exhibition," by Sir Augustus Adderley, K.C.M.G.

The report of the meeting will be printed in next's week's *Journal.*

EXAMINATIONS, 1887.

The list of successful candidates in the Examinations for the present year has been printed, and is forwarded to the Institutions in Union with the present number of the *Journal.* Copies will also be sent to the various Committees for the successful Candidates.

Proceedings of the Society.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 18th, 1887; Sir Frederick Bramwell, D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Faviell, Frederick Henry, The Cottage, Loughton, Essex.

Rodriguez, Epifanio, 12, John-street, Adelphi, W.C.

The following candidates were balloted for and duly elected members of the Society:—

Adamson, Robert Lawrence, 7, Balfour-road, Highbury New-park, N.
Beaumont, Robert, The Yorkshire College, Leeds.
Gillman, Alexander William, Chalmers, Park-hill-road, Croydon, Surrey.
Kibble, John Baxter, 89, Upper Thames-street, E.C.

The paper read was—

FIFTY YEARS' PROGRESS IN TELEGRAPHY.

By W. H. Preece, F.R.S.,
Vice-President of the Society.

This is the jubilee year of the electric telegraph in England. On July the 25th, 1837, the first practical trial of telegraphy was made between Euston and Camden, on the London and North-Western Railway, by Cooke and Wheatstone. Nine tedious years were spent in endeavouring to create enthusiasm among financial circles for this young and novel means of communication. The first company formed to develop the business of transmitting and delivering written telegrams was incorporated in 1846, and was called the Electric Telegraph Company. Wires were speedily extended to every great centre of trade along the great railways that were then being developed, and about 1851 the business was fairly established. Telegraphy and railways have grown up side by side. In 1851, submarine telegraphy was proved to be practical. Cables were laid in 1852 and 1853 to France, Belgium, Holland, and Ireland, and from that year domestic and international telegraphy grew and prospered. The Electric Telegraph Company suffered the fate of all prosperous initiators of that which is novel, useful, and successful. The validity of their patents was contested, the strength of their business was assailed all along the line by enterprising competitors. Their monopoly was broken; but the public gained by this active rivalry greater development of communication and considerable reduction of rates. We see the same process going on at the present day with respect to telephones, but with less success.

The rates for messages, which were as high as 12s. 6d. for twenty words, were based on a sliding scale. The rates for a message of twenty words were fixed at 1d. per mile for distances under fifty miles, then ½d. per mile up to 100 miles, and ¼d. per mile for a distance of more than 100 miles; addresses forming part of the twenty words. A message to Glasgow cost 8⅗d. per word, to Manchester 5$\frac{1}{10}$d.

Various reductions took place from time to time. In 1864, that is in less than twenty years, three great companies competed in every principal town for this profitable business of telegraphy. The United Kingdom Telegraph Company was formed in 1861 to introduce the universal shilling rate; but the severity of the competition of their opponents was too great for this spirited company, and they had, in 1865, to submit to the following general tariff:—Within London and other towns, 6d.; within 100 miles, 1s.; within 200 miles, 1s. 6d.; over 200 miles, 2s., addresses being sent free.

The public now began to suffer. Only the larger towns, where profitable business could be tapped, were served. The smaller towns were neglected, and great villages had to suffer the aggravation of seeing posts and wires pass through their main thoroughfares without being able to avail themselves of this speedy mode of communication.

Telegraphy became a necessity of the age for the due and proper transaction of business. It became so closely allied with other modes of communication that public opinion, in 1868-9, forced the Government to purchase and absorb all the telegraph companies, and to transfer their business to the care of the Post-office, which had shown itself so capable in dealing with letters and newspapers, and in establishing the penny post.

The telegraphs of this country again became a great monopoly; but there is a vast difference between a monopoly in the hands of a private speculative corporation, subject to no control but that of its own close ring, and whose sole object is to earn dividends, and a monopoly in the hands of the Government, whose sole object is to serve their masters the public faithfully and well, and whose actions are incessantly supervised by the jealous and watchful eyes of those they serve, who have an equally watchful and much less tolerant press in which to air their wrath and grievances, and an active House of Parliament ever ready to counteract and reform real abuses when fairly and properly laid before it.

It is impossible to conceive supervision more complete than that to which the Post-office is subjected. The receiver of every letter, the transmitter of every message, the editor of every newspaper, the reader of every news despatch, every householder or business man, can see for himself how his own business is conducted; he can growl and grumble to his heart's content at any error or delay that may occur, with a certain knowledge that his complaint has

been heard, and, if just, remedied, although he may not always be satisfied with the attention he receives. The telegraphic business of this country has reached its present dimensions because the work has been done well, and it has been done well because the mode of doing the business has been so well and so thoroughly supervised by the public.

The transfer of the telegraphs to the State took place on February 5th, 1870. The tariff established by Parliament was a uniform tariff of 1s. for twenty words, addresses being sent free, and this tariff remained in force until October 1st, 1885, when the present simple word tariff of ½d. per word, irrespective of distance, and including addresses, with a minimum of 6d., was introduced.

The average cost for the transmission of a telegram immediately before the transfer was 2s. 1¾d. After the transfer it was reduced to 1s. 1d. It is now 8d.

The number of offices open to the public prior to the transfer was 2,932, but owing to the existence of three large companies in the same town, the number of towns in telegraphic communication was probably not more than 2,500. There are now 6,514 offices open to the public. [Table I.]

TABLE I.—*Statement of Number of Telegraph Offices open at the end of each year since the Transfer:*—

	Post Offices.	Railway Stations.	Totals.
At the Transfer (viz. 5th Feb. 1870	1,058	1,874	2,932
On the 31st March, 1871	2,171	1,903	4,074
,, ,, 1872	3,266	1,886	5,152
,, ,, 1873	3,579	1,879	5,458
,, ,, 1874	3,671	1,879	5,550
,, ,, 1875	3,706	1,879	5,585
,, ,, 1876	3,736	1,866	5,602
,, ,, 1877	3,734	1,636	5,370
,, ,, 1878	3,756	1,555	5,311
,, ,, 1879	3,853	1,401	5,254
,, ,, 1880	3,924	1,407	5,331
,, ,, 1881	4,015	1,423	5,438
,, ,, 1882	4,146	1,449	5,595
,, ,, 1883	4,247	1,494	5,741
,, ,, 1884	4,370	1,503	5,873
,, ,, 1885	4,512	1,515	6,027
,, ,, 1886	4,740	1,524	6,264
,, ,, 1887	4,972	1,542	6,514

But the amount of business done is a better criterion of the benefits that the public have derived from the transfer of the telegraphs to the Post-office. At the close of the year 1870, the gross receipts of the Telegraph Department were £612,301; at the close of 1886 they were £1,787,264, and at the close of this year they will probably reach £1,950,000. The number of messages transmitted in 1869 was 6,000,000; in 1870, there were 9,850,177; in 1880, there were 26,547,137; in 1886, there were 39,235,813; and at the end of this year (1887) they will probably exceed 52,000,000. [Table II.] The diagram in the next page exhibits graphically the rate of growth of messages and wires, and it illustrates pointedly the result of the ½d. per word tariff, the success of which has exceeded all estimate and anticipation.

TABLE II.

Year.	Miles of wire.	Public messages.	Receipts.	Expenditure.
			£	£
1870-71	68,998	9,850,177	612,301	350,376
1871-72	87,719	12,473,796	735,390	496,694
1872-73	105,285	15,535,780	973,332	833,908
1873-74	108,553	17,821,530	1,049,162	956,170
1874-75	109,778	19,253,120	1,167,745	1,081,937
1875-76	113,216	20,973,535	1,287,623	1,106,912
1876-77	113,333	21,726,143	1,328,315	1,208,401
1877-78	114,009	22,171,867	1,352,668	1,227,560
1878-79	114,242	24,459,775	1,369,467	1,161,551
1879-80	114,902	26,547,137	1,469,795	1,173,287
1880-81	121,052	29,411,982	1,633,886	1,308,453
1881-82	126,734	31,345,861	1,654,390	1,440,498
1882-83	132,456	32,092,026	1,768,070	1,583,876
1883-84	140,499	32,843,120	1,789,223	1,808,920
1884-85	155,568	33,278,459	1,784,414	1,820,764
1885-86	170,196	39,235,813	1,787,264	1,832,401

The development of telegraphy is better shown in our great central station than anywhere else. The following Table is interesting:—

TABLE III.

Date.	One day's Messages.	Instruments	Staff.		
			Male.	Female.	Total.
Before transfer	8,500	...	...	...	...
1870	12,000	350	280	485	765
1880	43,000	486	826	598	1,424
1886	98,570	945	1,490	802	2,292

The number of messages dealt with each day ranges from 70,000 to 100,000, nearly half of which are transmitted messages which have to be both received and forwarded, and therefore become, practically, two messages,

although they count as only one in the total.

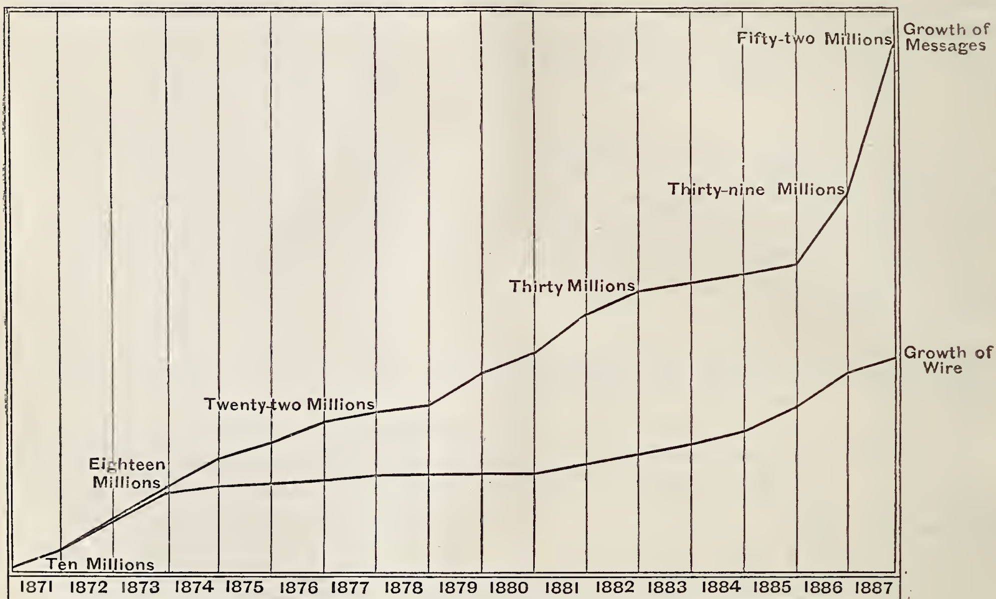
The local traffic in London—that is, messages emanating from one part of London for delivery in some other part, and passing through the central station—is very large. It ranges from 12,000 to 18,000 messages per day. In 1868 there were 60 offices open in the metropolis, dealing with 300 messages per day; there are now 480 offices, dealing with an average of 15,000 messages a day.

The total number of local metropolitan messages for four weeks was:—February, 1870, 138,534; January, 1880, 726,199; January, 1887, 1,277,838. A tenfold growth nearly.

PRESS ARRANGEMENTS.

One of the great objections raised against the absorption of the telegraphs by the State was the difficulty which the Government would have in transmitting news. In no country is there now such a complete system of telegraphy for news purposes as there is in the United Kingdom. Two complete news circuits serve always (day and night) the following important centres from London:—

1. Newcastle, Edinburgh, Glasgow, Dundee, Aberdeen.
2. Nottingham, Sheffield, Leeds, Bradford.
3. Birmingham, Manchester, Liverpool.



4. Bristol, Gloucester, Newport, Cardiff, Exeter, Plymouth.
5. Brighton, Portsmouth.
6. Dublin, Cork, Belfast.
7. Northampton, Leicester, Derby.

There are several other groups in the provinces served from these centres, and every evening after 6 p.m. a third, and frequently (especially in the Parliamentary session), a fourth circuit is made up to all these stations from London. Each office on each of these groups receives simultaneously the news sent from London. Thirty newspapers obtain the use of special wires, with clerks' services, from 6 p.m. to 6 a.m., many, like the *Scotsman*, the *Newcastle Chronicle*, and the *Manchester Guardian*, having two circuits; and whenever any great political event arises, such as the delivery of a great speech, all the important towns throughout the kingdom receive simultaneously a *verbatim* report of the speech. There is not a town in the country where a daily paper is printed which is not placed, after 6 p.m. in direct communication with London, and where there is not deposited on every subscriber's breakfast table a nearly *verbatim* report of the previous night's debate in Parliament.

The press rates are very low. The average price paid is a little in excess of 2d. per 100 words. This entails a loss to the Department roughly estimated at £200,000 a year, which is the amount the public is taxed for the support of the press. It is doubtful whether Parliament knew when it passed this low rate

that it virtually meant a subsidy to the press. The loss might be very materially diminished if there were less competition and more union among newspapers and news agencies. As it is, the same matter has frequently to be sent twice over the same route, and the amount of unnecessary news sent, and therefore, unnecessary expense, is enormous, much of it finding its way into the waste-paper basket. The supply of news, before the transfer, was very meagre. Reuter's telegrams, Parliamentary reports, general news, markets, races, were supplied for £200 a year. The companies did this jointly, and news was collected as well as distributed; but the Post-office is simply a carrier. It is not allowed to collect, and it is thus saved much of the obloquy that attached to the irresponsible monopoly of the telegraph companies. The average number of words supplied to each newspaper was said to be 4,000 a day. It is now roughly estimated at about an average of 12,000 in the recess, and 15,000 or 20,000 in the session.

The following will give some idea of the total number of words sent on one evening, on important political occasions, from the central station: —

April 8th, 1886.—Mr. Gladstone's Home Rule Bill, 1,050,500 words.

April 16th, 1886.—Land Purchase Bill, 841,500 words.

June 7th, 1886.—Irish Government Bill (Division), 863,700 words.

Table IV. shows how rapid and great has been the increase in this branch of our business.

TABLE IV.—*Return showing number of Press Messages dealt with during one week, in the years* 1871, 1879, 1882, *and* 1887, i.e., 1-52*nd part of the number for the year*

	1871.	1879.	1882.	1887.
Number of copies delivered	32,413	49,458	57,783	82,499
,, of words in forwarded messages, by day	158,174	195,503	273,610	316,498
,, ,, ,, ,, by night	334,897	971,439	914,754	1,150,316
,, ,, delivered	3 598,380	5,887,129	6,557,045	9,265,315

This does not include prepaid press messages. It only includes messages sent under "Passes" and under "Services."

Apparatus.

It is, perhaps, in the character and form of the apparatus used to transmit messages that the greatest progress has been made. It is difficult to say whether increased business has led to better apparatus, or whether improved apparatus has led to large business. One thing is certain, that the better the work is done the more is business encouraged, and work cannot possibly be well done if the apparatus used for discharging that business is inefficient or backward. When the Post-office assumed the control of the telegraphs, it amalgamated into one department an incongruous combination of various systems, worked by differently trained staffs, due to various companies having been formed at different periods to work different patents. The Electric Telegraph Company established the needle system of Cooke and Wheatstone, the printing system of Bain, which merged into that of Morse, and the various improvements patented by Varley; the Magnetic Company fathered the magnetic system of Henley and the bell system of Bright; the British Company introduced the system of Highton; the United Kingdom Company promoted the beautiful type-writer of Professor Hughes; and the Universal Private Company was established to introduce the simple A B C system of Wheatstone.

We had telegraphs that appealed to the eye like the needle, those that appealed to the ear like the bell, some recorded signals in ink like the Morse, others printed their characters in bold type like the Hughes. Some were slow but simple, like the A B C, others were fast but complicated, like the automatic. Time and patience were needed to consolidate into homogeneity this heterogeneous collection of telegraphs and telegraphists. Some years elapsed before the doctrine of the survival of the fittest was established.

Now, in 1887, the predominant telegraph instruments are the simple sounder and the fast speed automatic recorder. Reading by sound is confined almost exclusively to the United Kingdom and to the United States.

In Europe there is scarcely a sounder outside our islands. This is very remarkable, for the sounder is simpler, more expeditious, and more accurate, than any other key system. Those who have been educated to regard a record as an element of accuracy can only be convinced by actual experience that it is an element of error, and this experience they will not seek. The argument they use against the adoption of the sounder, viz., its liability to error, is devoid of any foundation in fact.

TABLE V.—*Comparative Return, showing the Number and Descriptions of Telegraph Instruments in the United Kingdom.*

Year.	Automatic.	Sounders.	Printers.	Needles.	Bells.	A B Cs.	Miscellaneous.	Total.
1877...	164	1,294	1,692	3,680	210	4,572	129	11,741
1878...	167	1,380	1,560	3,495	277	4,641	859	12,376
1882...	224	2,000	1,330	3,791	313	4,398	2,035	14,091
1886...	384	3,181	1,368	4,003	388	3,883	5,179	18,386

During the past ten years, a complete revolution has been effected in the quality and manufacture of our instruments. Exact measurement and scientific principles have supplanted rough and ready methods. Complete specification and rigid inspection have replaced cheap and nasty competition. The workmanship of a good telegraph instrument is to be rivalled only by that of a chronometer. Technical training has converted the workshop into a scientific laboratory.

The rapid increase of business that resulted from the uniform shilling tariff soon led to the erection of more wires, and the multiplication of wires soon attracted attention to methods of duplexing and quadruplexing the circuits. The duplex system means a mode of sending two messages in opposite directions at the same time. This was shown to be possible by Gintl, in Vienna, in 1853, but the necessity for such a system did not arise until 1872, and as at the moment a want is felt something is sure to turn up to supply this want, so when duplexing was needed Mr. Stearns arrived from America with a well worked out practical system, that was at once adopted, improved, and perfected. Still further congestion arising, quadruplex working, or the art of sending four messages on one wire at the same time, became desirable, and a practical quadruplex system, due to Mr. Edison, was imported in 1877 from the same inventive and practical region, the United States. The work of the Austrian Meyer ought also to be referred to. Later on, in 1885, a still further development was matured in America, viz., the multiplex system of Delany, by which six messages can be simultaneously sent on the same wire, which we have adopted, and the main features of which I now show you in action. The chief reason why these systems have been matured in America is that the want has been experienced there before it was felt here. Neither system was invented in America—each was invented in Europe. There are other wants that have been experienced here first, and those who have visited the States have found that English inventions are equally appreciated and adopted there. It is in automatic telegraphy that we have made the greatest advances. The following Table illustrates the progress made :—

	Words per minute.	Speed to Ireland.
1870	80	50·3
1875	100	70
1880	200	150
1885	350	250
1887	450	450

This increase has been due not only to improvement in the design of the apparatus, but to the steady examination of every defect and its removal, in the instrument, and on the line. It would require a paper of itself to narrate the ten years' conflict with electro-magnetic inertia, static induction, climatic influences, and battery defects. The Table tells the result of this conflict, and the battle is not yet over; and the Diagram (page 682) shows how scientific methods and improved apparatus have checked the rate of growth of wires, and have made cheap telegraphy possible. There still exists in our system a potentiality of expansion. We are now attacking the wires. Copper is replacing iron on our poles, with very advantageous results. Its better conductivity, and its entire freedom from electro-magnetic inertia, give it an immense superiority over iron. Its greater price per ton is compensated by its lesser weight per unit resistance.

We are also examining and testing various modes of laying wires underground, with a view to attaining greater speed of working, hitherto the great difficulty which has checked the establishment of underground work.

One consequence of the introduction of these advanced systems of working has been the necessity of educating the operating staff

in the scientific and technical details of the business. The absence of technical knowledge in all branches has hitherto been a great difficulty to surmount. The technological examinations inaugurated by this Society, and continued by the City and Guilds Institute, have been most beneficial, but the most successful incentive has been the selection and promotion of those who have given their attention to their own scientific education. This evident necessity for technical knowledge is reacting on the higher Post-office officials, and one finds all over the country a healthful spirit of inquiry arising—a striving after something better than the mere perfunctory discharge of official duties. There is something so captivating in the development of the practical applications of electricity, that those who make a study of it, especially experimentally, find in it more real enjoyment than any puzzling over the vagaries of the modern poet, or poring over the meaning of ancient cynics can afford. A successful experiment is a distinct revelation—an admission into courts where, according to Bacon, are found "secrets not dangerous to know, sides and parties not factious to hold, precepts not penal to disobey."

Snowstorms.

We have been subject, at long intervals of ten years, to serious and destructive snowstorms, which have seriously damaged our overground wires. The wires constructed and maintained by the Post-office did not suffer very seriously, but those maintained along the railways out of London, and those erected by the Telephone Company overhead, were severely handled by the elements. In fact, in London, many unrepaired telephone wires are still seen dangling over the housetops. No accident to person has been recorded, but the very serious interruption to communication has directed earnest attention to the necessity of putting more wires underground. It has always been the practice of the Post-office to do this in London and large cities, but not only the excessive cost, but the diminished speed of working, has hitherto prevented its being done to any large extent in the country. The Postmaster-General has now under his consideration a scheme for using underground wires more extensively, and there is nothing whatever to prevent this being done by the Telephone Companies. In fact, in many cases, telephones work better underground than overhead. The laws that govern the transmission of speech are now thoroughly known, and the fancied difficulties in using underground wires have vanished into thin air.

In London alone we have 255 miles of pipes, containing 10,212 miles of wire. In fact all our great trunk lines are out of danger from stoppage from storms. We have 868 miles of open wire included within the metropolitan area, but these are chiefly in the suburbs, and include long outlying sections, used either for police or fire brigade wires, or for private persons.

There are 213 offices in London now served wholly by buried wires. It will be seen, therefore, that the Post-office has been fully alive to the drawbacks attending the existence of overhead lines in crowded centres. It is steadily pursuing the same policy, and although some open wires must exist if telegraphs are to exist at all in certain localities, still the overhead proportion, as compared with the underground, steadily diminishes.

TABLE VI.—*Comparative Return, showing the Mileage of Line and Wire in the United Kingdom.*

Year.	Overhead.		Underground.	
	Line.	Wire.	Line.	Wire.
	Miles.	Miles.	Miles.	Miles.
1877	23,766¼	101,627¼	394¾	8,013¾
1878	24,438¾	102,074	445¾	9,023
1882	25,001½	111,811¾	478¾	10,993¼
1886	26,425	150,590	677¾	19,605

To provide a scheme extending throughout the kingdom to only connect the more important towns, and uniting those towns by less than half the existing number of overhead wires, would cost something like £2,500,000, and in these days of attenuated exchequers such an outlay is very serious to incur, although it may effectually guard against stoppages ranging from three days to three weeks, once in five years or so.

Telephones.

In 1877, a most striking departure in telegraphy was made by Professor Graham Bell in America, who showed that it was possible to reproduce for commercial purposes the human voice at great distances. The telephone sprang into existence almost perfect in its

action, and with the improvements immediately afterwards introduced by Mr. Edison and Professor Hughes, it has continued to progress with giant bounds. In America there were on December 31, 1886, 353,518 telephone receivers and microphone transmitters in use and under rental. The total number of subscribers to Exchanges is 147,068. In Europe the number is very great. The number of Exchanges in England is 184; there are 19,784 subscribers, but there are 101,000 telephones in use as Royalty-paid receivers and transmitters.

Stockholm has shown a remarkable development. With a population of 210,000—about the size of Edinburgh—there are over 5,000 subscribers to the Exchange, while in Edinburgh there are only 372.

Pneumatic Telegraphs.

The Electric Telegraph Company introduced, in 1854, a pneumatic tube of lead protected in iron pipes, between their central station in Lothbury and the Stock Exchange, through which the messages themselves, in small leather carriers, were driven. The system proved so economical and rapid, that it was extended in the City of London, Glasgow, Liverpool, and in Manchester.

At the transfer there were altogether 2 miles 1,625 yards of pipes laid down, but now there are in:—

London	32 miles,	1,209 yards.
Birmingham	0 ,,	917 ,,
Liverpool	5 ,,	1,593 ,,
Newcastle	0 ,,	1,204 ,,
Glasgow	1 ,,	768 ,,
Dublin	1 ,,	1,013 ,,
Manchester	2 ,,	233 ,,
Total	44 miles,	1,737 yards.

The longest tube is that between the central station, General Post-office, and the House of Commons (3,859 yards), through which 700 messages are sometimes sent, each carrier taking about six minutes per journey, but intermediate signallers being employed, carriers can be despatched every two minutes. In most cases there are two tubes, one for sending and the other for receiving—through one the messages are blown, through the other they are sucked—the engines and pumps being in all cases in the central station. At the time of the transfer the engine power employed was as follows:—

	Engines.		h.-p.
London Telegraph Station	1	..	20
Birmingham	1	..	6
Liverpool	1	..	8
Manchester	1	..	10
Glasgow	1	..	6
Total nominal horse-power			50

The engine power employed at present is as follows:—

	Engines.		h.-p.
London:— St. Martin's-le-Grand—Condensing engines. (3 are working and 1 spare)	4	each	50
Liverpool—Condensing engines. (2 are working and 1 spare)	3	,,	30
Manchester—(1 is working and 1 spare)	2	,,	10
Birmingham	1	..	6
Glasgow	1	..	20
Newcastle-on-Tyne	1	..	8
Dublin—(1 is working and 1 spare)	2	each	10
	14	..	134

This gives a total of 14 engines, and a total of 364 nominal horse-power for working the 112 pneumatic tubes now in use.

TABLE VII.—Submarine Cables.

Government Administrations.	Number of Cables.	Length in nautical miles.
Germany	35	461
Austria	31	96
Denmark	36	123
Spain	3	127
France	46	3,197
Great Britain and Ireland	104	876
Greece	45	457
Italy	22	613
Norway	236	228
Netherlands	20	59
Russia in Europe and the Caucasus	5	201
Sweden	9	61
Turkey in Europe and in Asia	8	330
Cochin China	3	810
British India, Indo-European Tel. Dept.	5	1,718
,, ,, Indian Administration	67	155
Japan	11	55
Russia in Asia	1	70
South Australia	5	49
New Caledonia	1	1
Dutch East Indies	1	31
New Zealand	3	196
British America	3	200
Brazil	19	19
Total	719	10,142

SUBMARINE CABLES.—*Continued.*

Companies.	Number of Cables.	Length in nautical miles.
Submarine Telegraph Company	10	803
German Union Telegraph Company	2	1,119
Hamburg-Heligoland Telegraph Company	2	40
Direct Spanish Telegraph Company	2	699
Spanish National Submarine Telegraph	5	1,172
India Rubber, Gutta Percha, and Telegraph Works Company	2	122
West African Telegraph Company	11	2,825
Black Sea Telegraph Company	1	351
Indo-European Telegraph Company	2	14
Great Northern Telegraph Company	20	6,108
Eastern Telegraph Company	53	18,838
Eastern & South African Telegraph Company	5	4,554
Eastern Extension, Australasia and China Telegraph Company	21	12,035
Anglo-American Telegraph Company	15	10,437
Direct United States Cable Company	2	2,983
Compagnie française du télégraphe de Paris à New York	4	3,409
Western Union Telegraph Company	4	5,537
Commercial Cable Company	6	6,937
Brazilian Submarine Telegraph Company	6	7,326
African Direct Telegraph Company	7	2,739
Cuba Submarine Telegraph Company	3	940
West India and Panama Telegraph Company	20	4,119
Western and Brazilian Telegraph Company	9	3,801
River Plate Telegraph Company	1	32
Mexican Telegraph Company	2	709
Central and South American Telegraph Company	9	3,178
West Coast of America Telegraph Company	7	1,698
Total	231	102,531

SUMMARY.

Offices.	Number of Cables.	Length in nautical miles.
Government Administrations	719	10,142
Private Companies	231	102,531
Total	950	112,673

CABLES.

The exclusion of private enterprise from telegraphic undertaking in these islands does not apply to our colonies and to the ocean. The growth of submarine telegraphy has been enormous. We read in our newspaper every morning the previous day's doings in every quarter of the world. The *Times* of Monday morning last had two and a-half columns from Philadelphia, one column and a-half from India, a despatch from Natal, another from Melbourne, and news from every capital in Europe.

In 1851, two or three far-seeing individuals, prominent among whom was our own Vice-President, Mr. T. Crampton, risked their capital in laying a cable between Dover and Calais. Now their are 112,673 miles of submarine cable resting on the bottom of the ocean, which have absorbed a capital of £37,000,000. Table IV. gives a list of them.

No less than nine cables cross the Atlantic All our important colonies are in connection with London—the heart of the world. Laying and repairing has become a simple and a certain matter in any depth and in every sea. A whole fleet of ships—over thirty—are maintained for the purpose. Submarine telegraphy has become a solid property—the main result of British skill and British enterprise—unaided by Government support. The apparatus used is principally Sir William Thomson's recorder.

RAILWAYS.

The monopoly which the Postmaster-General possesses regarding telegraphy only applies to message-carrying for profit—it does not apply to those numerous wires that are required for the protection of life on railways. Each of our large railway companies has a distinct telegraph system of its own, employing a very large staff, and used for the purpose of regulating its own traffic. There are about 80,000 miles of wire erected for the purpose, and probably 20,000 instruments in use of various kinds. The apparatus used for telegraphy is invariably the needle, though generally on the wires connecting the Post-offices sounders are employed. The apparatus used for block working is very various. Every great railway out of London has a different system. The survival of the fittest has not yet asserted itself. But they all work well, and without electric signalling the working of our railway system would be absolutely impossible.

FINANCE.

The financial position of the telegraph business is sound. The amount of capital debited against telegraphs is £10,140,000; of this, £7,000,000 was the purchase money, the rest has been expended in extensions and in furthering the business. If the trust which the Post-office undertook on behalf of the public were handed back to the care of private enterprise, we should hand over a going business

drawing a gross revenue of nearly £2,000,000 per annum, and assets which may be estimated at £4,000,000. If financiers were willing to pay several millions for a single brewing business in Dublin, what would they pay for a grand Imperial monoply, serving every town in the United Kingdom, and of which every person in these islands is a customer?

It is very much the fashion to decry the terms of purchase. Doubtless, the terms paid were very high, and the Post-office authorities who negociated the purchase were unnecessarily hurried, and perhaps overmatched by the railway companies, for they had to pay twice over for certain privileges. Even Mr. Fawcett proposed to wipe out as wasted capital the excess paid for telegraphs, and call it a bad debt. As the bargain stands, the public have not been losers. A Government department cannot compete in economy with an ordinary commercial firm subject to competition; nevertheless, the business done pays a dividend on the capital expended. The balance of profit for the year ending 31st March, 1886, if our accounts were made out on commercial principles, was £160,000.

It is amusing, after this length of time, to read the arguments that were adduced against the absorption of the telegraphs by the State. Every reason has been proved wrong, every prophesy has remained unfulfilled. I can say this with a good grace, for I was one of the prophets.

The advantages of a State-controlled telegraph system have been amply shown. There has been established a cheaper, more widely extended, and more expeditious system of telegraphy; the wires have been erected in districts that private companies could not reach; the cost of telegrams has been reduced, not only in their transmission but in their delivery; the number of offices opened has been trebled; a provincial and an evening press has been virtually created. Adam Smith said that the Post-office was the only kind of business that Government had always managed with success. We can now add Telegraphy.

DISCUSSION.

Prof. Hughes, F.R.S., said that Mr. Preece had given such a full account of the progress of telegraphy that he had left little or nothing for others to say. As reference had not, however, been made to the progress in batteries, he should like to ask one question. In the United States, and also in England, they had tried to use dynamos in the place of batteries, and, according to reports from California, it appeared they had had some success, and he should like to know whether Mr. Preece had met with any success in this direction. As reference was made in the paper to Mr. Meyer as the inventor of a perfected system of telegraphy, he might, perhaps, be allowed to say that Mr. Meyer did not belong to Vienna, but to Paris, and the apparatus was first brought out there. Great credit was due, not only to him, but also to the French Government; and, in fact, to most of the Continental Governments, for the encouragement they gave to their *employés* to make improvements. Whenever an idea was brought forward by an *employé* of the Administration, it was submitted to examination, and if it appeared promising, a certain sum was given to develop it. Mr. Meyer was but a clerk, but he had 10,000 francs given him, and a holiday to perfect his invention, and he succeeded in producing a most beautiful instrument.

Mr. J. W. Batten said he was more acquainted with telephony than with telegraphy, being the recipient of one of the first instruments made by Professor Bell, and one of the originators of the United Telephone Company. Comparing telephony in England and America was like comparing an eagle in the Zoological Gardens with one in a state of freedom. Telephony in England was restricted by the Post-office, but if it were allowed one quarter of the free play it had in America, very different results would be seen. When he was in California last year, and in Buenos Ayres the year before, he paid special attention to the working of the telephone, and in both places he found it had developed because it was allowed to do so. Here he could not telephone to a shopkeeper to call a cab for him, because the Post-office said it was a message. In America he could call to a shopkeeper, "Be kind enough to send a cab to my house," and it was done at once; and he was told the cab was coming. In America he could send a message to a commissionaire at one of the offices to send some one to execute a commission, such as to fetch his dress clothes from home, but he could not do that in England, or if he could, he could not send a message to his wife to say where he was going to dine. In San Francisco he counted 47 stable-keepers on the telephone, 108 doctors, and about 74 chemists, and the way it was worked was this. Almost every respectable house was on the telephone, and if the doctor was wanted he was telephoned for. While dressing he telephoned for a cab, which was at the door by the time he was ready, and immediately he had seen the patient he telephoned the prescription to the chemist, and in a few minutes the medicine was at the house. In every street in America you found a shop in which were two or three young ladies with telephones, and for 2½d. one of these young ladies would send a message for you or you could do it yourself. At San Francisco there

was communication with 102 towns and villages in the neighbourhood, one of them, Sacramento, being 104 miles distant. In fact, everything was done to popularise the telephone, and it was entirely free from Government supervision or control. Invention always succeeded where there was freedom. It was very respectable to be in livery, but it was much better to be free. He did not say that the Post-office authorities were not, to a certain extent, right in handicapping the telephone, having bought certain telegraphic rights; but when the public blamed the telephone companies they should remember that they were not allowed to go along a single line of railway, to enter a railway station, to call a cab, or scarcely to do a single thing which was done in America. Still, with all that, they were sending 60,000 messages in London alone daily through the telephone system, a number compared to which that sent by the Post-office was miserably insignificant. And many of these were messages which no telegraph could touch. On Monday week, when in his chambers, he received an invitation to the opening of the American Exhibition, with six tickets. Not being able to go himself, he telephoned home to ask if there were any friends there who could use the tickets if he sent them, he received a reply, and in about half an hour he had sent the tickets, and his friends were on their way to the Exhibition. The telegraph and telephone were totally different things, but each might largely assist the other, as might be seen by the enormous increase in the number of messages directly Professor Bell's invention came into operation. If the Post-office would relax its grip on the telephone companies, and work with them thoroughly to develop telephony, both would be benefited, and the public also.

Mr. Patey, C.B., said, as the rules for the working of the telephone systems in England were well-known, it was not necessary to enter into a justification of the reasons which had led the various Post-masters-General to make those rules. The paper had only touched slightly on the question of telephones, as it had been prepared with the object of setting forth the progress which had been made in telegraphy, a subject especially suitable to be brought before public notice in the Jubilee year of her Majesty, and the jubilee of telegraphs. The statements and the statistics given, had not been made with a view to glorify the Post-office *per se*, but to show what progress had been made in this as in many other arts which had grown up during her Majesty's reign. Mr. Preece had endeavoured to show that the Post-master General, and the officers under him, had tried to work for the public good, in order to give, according to the words of the preamble of the Bill of 1868, a more extended, more expeditious, and cheaper system of the telegraphs to the public. When it was recollected that, in 1870, the number of telegrams was one to each five of the population, and that now it was one and a-half to each person, it would be seen there had been a great extension, for which the officials of the Post-office might take some credit for having brought about. Care had been taken to transmit messages with rapidity and regularity—not with rapidity now and then, but constantly by the introduction of new wires and apparatus, to meet the large increase of business which had taken place since the introduction of the 6d. rate. Notwithstanding this enormous increase of eleven millions in one year, the business was now better done than before, first, by the increase in the number of wires; secondly, by the greater perfection of apparatus, and chiefly by the very great care and attention which had been given, not only by the officials who had to deal more especially with the putting up and maintenance of the wires, but by the operators throughout the country, who had during the last two years devoted themselves to the work in hand, and had been able by the experience they had gained in previous years to transmit the messages under the new system with more rapidity and clearness, and with less errors. As an official of the Post-office, he thought great credit was due to the operators for the very satisfactory way in which they had carried on their work. In this, the Jubilee year, it was satisfactory to find that from 1837 with its simple forms of apparatus they had now the Wheatstone, with its power of transmitting messages at the rate of 450 words per minute, and the Delaney instrument, by which six messages could be sent at the same time on one wire. He thought this reflected great credit on the inventors, on the Post-office officials who improved the apparatus, and to the operators who dealt with the work.

Mr. Lascelles Scott said he should like to ask a question with regard to a point on which the late Mr. Cromwell Varley and he had had a conversation shortly before his death. It was with regard to the property of selenium when in the crystalline condition of being acted upon by light, and Mr. Varley had the impression that duplex telegraphy might be very greatly developed by the use of this material. He should like to ask Mr. Preece, therefore, whether he had any information to give on this point, and whether it would not be possible, by a revolving beam of light on plates of selenium specially prepared, to send 24 messages over the same wire.

Mr. Alfred Carpmael said it would appear from Mr. Preece's papers, given there from time to time, that they ought to be very much obliged to the Post-office for having taken over one of the great industries of the country, and he was not disposed to deny that in some cases there might be some slight advantage; isolated villages might have got the telegraph a little sooner than they would have had it if the company of which Mr. Preece was so able an official had still continued to carry on business; but he very much

doubted whether they had the sixpenny telegram as soon as they would have had it if the Government had not taken them over. The matter was actually under consideration in 1869. There was one fact which evidently weighed even with Mr. Preece. England at one time was in the foremost rank of inventors. Cooke and Wheatstone got a telegraph to work before anyone else did, but from 1869 in this country not one single invention of importance had been produced. As an Englishman, he felt humiliated when he heard such names as Stearns, Delany, and Bell—for we had no one to put beside them. Why was this? Mr. Preece said it was because, whenever they wanted an invention, there came just in the very nick of time someone from America with one. But supposing there had been a Government monopoly in America; he doubted whether the some one would have stepped in, in the nick of time, and probably telegraphy would have progressed as slowly in America as it had done here. At the close of the paper, Mr. Preece said that telegraphy was free in the Colonies, and that submarine telegraphy had progressed there with immense strides, because there was freedom, and people might do what they liked. He believed, whatever their obligations to the Post-office might be, they must at least make a deduction for its having stifled inventive genius. Inventors frequently came to him, sometimes with electric telegraph inventions, and said they were told it was no use patenting them, because the Government would not touch an untried thing, and they could not try then themselves. If an American came to the Government, he had this advantage, that he had been allowed to try his plan in his own country, and it had proved a success, and he was therefore in a position almost to compel the Government to take it up. One thing he was glad to hear from Mr. Preece, and that was the right of the public to grumble, and that if their grumbling had any justice in it, it would be attended to. He was extremely glad to hear that, because he had that day addressed a complaint to the Department on his own account. A regulation had been passed in his neighbourhood, that a telegram with the same address as letters which found him by every post, should not be delivered, unless he paid an extra sixpence for what they were pleased to term re-directing. He was quite satisfied that it was not an unmixed advantage that the telegraphs were handed over to the Government.

Mr. GRAVES said he had heard in many places that the price paid for the telegraphs was too high, and that might or might not be the case according to the point of view. Mr. Preece said he was one who prophesied a loss as the result of the transaction, and he was another; but they had looked at it from the point of view of preserving a 10 per cent. dividend. That was earned by the Electric Telegraph Company in 1868, and anything which earned less was in one sense a loss. It had not earned 10 per cent. since, but the nation had greatly benefited; communication had been more extended; the press had been able to reach the uttermost parts of the kingdom, and places which would never have enjoyed telegraphic communication have received it, whilst the old companies only attended to the large centres. The companies were bought up at the full price of the dividend they were earning, and the railway companies were compensated for their reversionary rights, and the two came to a large sum more than the present business was worth, judging of it by the income, but not more than it was worth to the nation if valued by results. If Government purchased the telephones, no doubt Mr. Batten would say the same course ought to be followed, but he should say that experience ought to be the guide. It was to the advantage of the country generally that the telegraphs should be controlled by the State, because they were then administered for the benefit of the greatest number; it was not a money interest, or an individual or class interest, but simply the greatest utilisation of communication, and the greatest spread of the organs of communication between one part of the public and another. It was perfectly true, as Mr. Carpmael had said, that invention had not been so rapid since 1870, as before, simply because there was not the market for it. If you could form a company to bring out every new patent, every new patentee found his article sold, but whether it was to anyone's benefit but his own was another question. With the Post-office there was a certain organisation and certain needs to provide for, and they were provided for with what the department had at command, supplemented by what was offered. Since the last snowstorm he had officially considered no less than forty-five new ideas for patents, simply suggested by that breakdown. The great majority had no solid foundation whatever. The inventors in the first place overvalued their own ideas, and in the next place they overvalued the means by which they could carry it out. Probably a great many patentees originated their inventions, not because they were more advantageous, but because they had something which they hoped would find a market. That market had been lost; the department simply acted for the general good, and endeavoured to provide means of communication as widely as possible, and to develop the means for extending communication as far as was consistent with the preservation of the revenue.

The CHAIRMAN, in proposing a vote of thanks to Mr. Preece, remarked that whatever his heresies might be in the minds of some with regard to Government trading, no one could doubt that it was impossible to have a more competent writer of a useful paper for that Society, whether the paper were a statistical one or one involving the description of new and ingenious apparatus. As they were told that all complaints were attended to, and as he saw three high officials of the Post-office present, he would tell them one thing which would probably never have occurred to them, because they were accustomed to

deal with the ingenuity of people, not with their stupidity. There was a telegraph station at the Westminster-palace hotel, from which he had had to send messages, and although he put his proper address on those telegrams, the recipient, seeing that it was sent from the hotel, in two instances was unwise enough to send the answer there, the result being that it was mislaid, and did not reach him for two days. It might be desirable for Post-office purposes to know the office from which the message was sent, but he did not see the use of putting it on the message which was delivered, seeing the innate stupidity of human beings, and he hoped the practice would be discontinued.

Mr. GRAVES said the Post-office had last month altered the name of the office at the hotel.

The vote of thanks having been carried unanimously,

Mr. PREECE said this was another illustration of what he had stated, that whenever a complaint was made to the Post-office, it was immediately attended to. Still he thought it was unfair that the stupidity of the public should be made matter of complaint against the Post-office. He always felt a certain amount of satisfaction in bringing forward anything connected with the Post-office, because it gave everybody a chance for a growl, and fortunately, the complaints were very easily answered. Taking Mr. Batten first, this was an old subject of his, the restrictions which the Post-office put on the telephone, and the greater freedom which prevailed in America. He (Mr. Preece) had been to America especially to look into this question, and he found that in America a telephone company could not erect a post in the street of any town without paying a tax of five dollars, nor carry a wire through a street without being taxed four or five dollars a mile for it. In many states, instead of having to pay a tax of 10 per cent. to the Government, they had to pay more like 25 or even 30 per cent., and in one State—Indiana—the Government not only restricted the passage of the wires through the town, but restricted the charge to be made to subscribers; so that at present there was not a single telephone at work in a country as large as England, because the companies would not submit to this grand freedom that Mr. Batten spoke of. Had Mr. Batten ever tried to call a cab by telephone? Why long before he could get his call answered by the young woman at the exchange, a messenger would have gone to the cab stand and brought the cab. The reason why cabs and doctors were not called, was not because there was any restriction, but because the thing was so badly worked. A short time ago he was in the North with a friend, and after dining comfortably, they went into the smoking-room, where there was a table laid out with telephones upon it, and on applying them they could hear the opera. Could that be done in London? and was it on account of the Post-office restrictions? If you wanted to know how to work the telephone you must go away from London, to Newcastle or Liverpool, and away from Mr. Batten's company. Here, if you got hold of a telephone, you had to wait a long time before you were in communication, and then you were constantly interrupted by other persons' messages. Similar restrictions to those in London also existed in Paris, but there were many more telephones in use there. They had tried to work the telegraphs by dynamos, but had not succeeded, the reason being that the currents generated by these machines were very variable, and did not possess that uniformity which was essential for high-speed telegraphy. They had tried accumulators, and were still experimenting with them, and with great success, and he had no doubt that when they had the means of working the dynamos in order, they would be able to supplant a good many of the 25,000 cells now in use by secondary batteries. He was glad to have Professor Hughes's correction with regard to Mr. Meyer. As to the treatment of *employés*, almost identically the same system was adopted in England as in France. Every operator throughout the country had the means of experimenting and of communicating his ideas to the authorities; those ideas were carefully considered, and if they showed the least probability of being successful they were carefully tried, and if found useful were adopted, and the inventor rewarded. These rewards had had a very beneficial effect in increasing the facilities of the service. With regard to selenium, nothing whatever had been done, and he thought it was rather a wild notion of Mr. Varley's, which arose shortly after the discovery that selenium was affected by light. The great difficulty in making experiments with it was that there was seldom any sun in this country, which was about the only light which produced any appreciable effect upon it. Some present might remember the photophone of Professor Bell, by which he showed how it was possible to reproduce speech by means of the variations of light upon selenium. He was surprised to hear Mr. Carpmael say that previous to the transfer the Telegraph Company had considered the advisability of introducing sixpenny telegrams. He was a prominent officer of the company, but he had heard nothing of it; and more than that, he had only just been reading a powerful pamphlet, produced by that company to protest against the confiscation of their property, in which they brought forward irrefragable evidence to show that it was impossible to make even shilling telegrams pay. If in 1869 a shilling telegram would not pay, how could they have thought of introducing a sixpenny rate? Perhaps Mr. Carpmael might be right to this extent, that they considered the question of a sixpenny rate in cities. It was tried in London, though it was a misnomer, as you paid sixpence for the telegram and sixpence for the messenger, so that it was much the same as paying a shilling. Mr. Carpmael said there were no inventors in

England, but it must not be forgotten that the inventions of Sir William Thomson were used everywhere, as was also the microphone invented by Professor Hughes; in fact, all the great improvements, from those of Varley down, were brought out in England. The most important circuit inventions which were in use in every capital of Europe had been brought out in England. The officials of the Post-office did not patent inventions, and, consequently, any improvement brought out by them was not identified with any name. The paper itself contained sufficient evidence to refute any notion that invention was stifled in England. On the contrary, he believed the paper proved the very reverse.

Miscellaneous.

THE FLORENTINE STRAW INDUSTRY.

An account is given in the report just issued by Consul-General Colnaghi, of the Florentine straw industry. It is stated that this industry was originally confined to the *Contado* of Florence, where it existed in the 16th century. From this district it gradually spread into other parts of Tuscany and of Italy. The industry appears, however, to have become of importance only at the beginning of the 18th century, when Domenico Michelacci introduced or perfected the culture of spring wheat (*grano marzuolo*), sown thickly, from which an excellent straw is obtained. The first experiments were made on the hills round Signa, and their success caused this culture to be quickly extended to the neighbouring districts. The industry now is so generally extended throughout the Florentine district, that there is scarcely a family in which some of the members are not engaged in this work. Children begin to plait at five and six years of age, while the mothers of families, in addition to their domestic occupations, and females of all ages and almost of all conditions, who do not follow the business as a means of livelihood, employ their leisure time in it. Formerly, when the production was carried on by persons connected with agricultural labour only, the work was not constant, but now it goes on all the year round. In the cultivation and preparation of the straw, the seed used is carefully selected with regard to the nature of the soil in which it is to be sown. The quality employed is always a variety of spring wheat (*Triticum æstivum*). As the object of the cultivator is to produce a fine long straw, and not a full crop of wheat, all the usual conditions are reversed. Thus a spring wheat is sown in winter, a mountain variety on low lands; the seed is thickly instead of thinly sown, &c. The thicker the seed is sown the finer the straw comes out. Straw is largely grown about Campi, Sesto, and Prato, in the plain between Florence and Pistoia, diminishing in quantity in the neighbourhood of the latter city. The cultivation is important between Florence and Empoli, principally on the south-west side of the Arno, on the plain, and on the hills commencing in the vicinity of Signa. In the principal centres of cultivation straw is grown on nearly every farm. Plots of land are also hired at a money rent for this culture. The seed is sown very thickly towards the end of November, or the beginning of December. The ground is dug up and manured in May, and generally sown with spring beans and the like, which are often dug in. About October the ground is ploughed for sowing, and at the end of May, or the beginning of June following, when the ear is beginning to swell, the straw is pulled up by hand, a sunny day being chosen for the operation. The straw is then made up into bundles containing as much straw as can be easily held in the hand, and these bundles are tied up with broom. The gross produce of a hectare of land, the hectare being equivalent to about 2·47 acres, is calculated, approximately, at from 19,000 to 20,000 *manate* or bundles. The next operation which the straw undergoes is that of being bleached, which is effected by exposure to the sun by day and to the dews by night. The bundles are spread in fan shape on a bare river bank or other open space, which must be entirely devoid of vegetation. After four or five days exposure the straw will have acquired a light yellow colour. The bundles are then turned over, and the under part exposed in its turn for three or four days more, when the straw, after being well dried, is gathered in. When the dews are light, the process is slower but more perfect. In case of rain, the straw is at once heaped together, and covered over to prevent it becoming spotted. The straw is now ready for manufacture, the first operation of which is the *spilatura* or unsheathing the ends, leaving only the inner portion to be worked up, this is generally done by children. When unsheathed, the straw is carried to the factories, and after having been slightly wetted it is first exposed to the fumes of sulphur in a tightly-closed room. The straw has next to be sorted according to its different thicknesses. This is done by means of an apparatus which consists of a series of vertical metal cones placed on a stand in a double row, and provided with movable copper plates perforated at their lower ends. The holes in each succeeding plate are a size larger than those in the preceding one. The numbers generally range from 0 to 13, but sometimes they run up to 20, 0 represents the finest stems. A bundle of straw being placed in the first tube of the series, a saltatory movement is given to the machine by means of a combination of cog-wheels, generally worked by hand. The finest straws pass through the holes of the plate, where they are suspended by the ear. The larger straws are then put into the next tube, and so on until the whole is assorted, a constant supply being maintained. The sorted straws which have passed into the holes up to the ends, by which

they are suspended and prevented from falling through, are then drawn out by the ears and placed in separate receptacles. The first thing after assorting the straw is to cut off the ears, an operation termed *spigatura*, which is done by a special machine. Then follows the *spilatura*, or assortment into lengths, which is effected by placing on a table a small cylindrical tin case, open at both ends, and about eight inches in height, and eight inches in diameter, into which a loose bundle of the prepared straw is placed vertically. The operator sweeps his hand over the bundle, and draws up from it the longest straws which project above the rest. These he deposits in the first compartment of a table furnished with different divisions. He then draws from the bundle the next longest straws, and so on until he comes to the shortest. The straw is usually divided into five or six lengths for the finer kinds. The straw is of a better colour, more consistent and finer as it approaches the ear, the lower part, which is protected by an outer covering, being whiter and softer. Formerly this end was not used, but now it is employed for making all the articles that go under the name of pedal hats or pedal plaits. The sorted straw is next made up into small bundles, which are bound together in a large packet, the point or upper ends being placed upwards in two bundles, and downwards in the other two. The united packet is now laid under a cutter, and being divided through the centre yields four smaller packets, two of point and two of pedal straw, which are ready for the plaiter. The straw is given out to the plaiters either directly from the factory or through a factor, in bundles either sufficient to make a length of fifty yards of plait, or a hat as the case may be. Before being plaited, the straw is slightly wetted to render it more flexible. The hats are sewn either with waxed thread or with the fibre of a rush which grows on the marsh lands near Signa, and which is prepared for the purpose. On the plaits being returned to the factory, they are measured. The length being found correct, they are washed in potash water in order to whiten them, and occasionally they are cylindered to give them a polish. They are next wound upon a circular toothed frame of one yard in circumference, the teeth being to keep the strands of the plait evenly one over the other. They are then made up into packets of six or twelve pieces, or sometimes of twenty-four pieces, after which they are packed in cases for export. On the hats being brought to the factory, the loose straws are first cut from the brims, and any defects in the plaiting are made good by insertion, after which they are piled up on one another, and placed in large troughs full of potash water, in which they are pressed down by planks. They are then dried in the sun when the weather is fine, or in hot rooms when it is wet. The hats are then ready to be moulded into shape, which is effected by their being placed in heavy zinc moulds, and forced into shape by hydraulic pressure. They are next powdered with sulphur and polished with a small wooden instrument, and packed in cardboard boxes in dozens, and subsequently in wooden cases ready for export. According to the official trade returns, 18,000 cwt. of plaits and 3,399,000 straw hats were exported from Italy during the year 1885, chiefly to the United Kingdom, Switzerland, Germany, Austria, France, and North and South America.

Notes on Books.

SAFE RAILWAY WORKING: a Treatise on Railway Accidents; their cause and prevention, with a description of modern appliances and systems, by Clement E. Stretton, C.E. London: Crosby Lockwood, and Co., 1887.

The author, who is consulting engineer of the Amalgamated Society of Railway Servants of England, Ireland, Scotland, and Wales, has dealt particularly in his seventh chapter with the subject of railway servants and the law, and he refers to Mr. Mundella's statement in the House of Commons, that railway servants are the greatest sufferers by railway accidents, since in eleven years 6,584 had been killed, and 26,024 injured. In his first chapter Mr. Stretton gives a summary of accidents in 1885, in the second he deals with the permanent way, in the third with signalling and the block system, in the fourth with continuous brakes, in the fifth with the breaking of railway axles, and in the sixth with railway couplings. Appendixes are added, which contain particulars of railway traffic returns, signal returns, and continuous brakes returns.

AN ELEMENTARY TEXT-BOOK OF BRITISH FUNGI. Illustrated. By William Delisle Hay. London: Swan, Sonnenschein, Lowrey, and Co. 1887.

This work contains catalogues both of esculent British fungi, and also of British poisonous fungi. The author also deals with the question of the cultivation of certain fungi, and gives a series of culinary receipts, to which is specially added a menu for a fungus feast. The book is fully illustrated.

ENGLISH TOBACCO CULTURE, being a description of the first English and Irish tobacco crop of 1886. Edited by E. J. Beale, F.L.S. London: Marlborough and Co..

Mr. Beale has here collected a considerable amount of information respecting the various attempts made to grow tobacco in England. He describes the varieties of tobacco cultivated in England and Ireland by Lord Walsingham, Mr. Faunce de Laune, Sir Edward Birkbeck, Mr. Bateman, Messrs. Carter, and others, from seeds supplied by James Carter and Co., and these varieties are figured in this volume.

JARROLD'S NORWICH AND EASTERN COUNTIES ALMANACK AND CLERICAL DIRECTORY FOR 1887. Norwich.

This volume contains a clerical directory of the county of Norfolk, and a general directory of Norwich, besides much miscellaneous information respecting the city of Norwich.

THE ADVERTISERS' A B C. London Central Agency for Advertisements.

This is a general Press directory, with a notice of the scale of advertisement charges for each of the several London and provincial newspapers, magazines, reviews, &c.

MEETINGS OF THE SOCIETY.

INDIAN SECTION.

Friday evenings, at Eight o'clock:—

MAY 27.—"Indian Tea." By DR. T. BERRY WHITE. SIR ROPER LETHBRIDGE, C.I.E., M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 24.—"The Importance of the Applied Arts and their Relation to Common Life." By WALTER CRANE. PROF. HUBERT HERKOMER, A.R.A., will preside.

CANTOR LECTURES.

The Fifth and Concluding Course will be on "The Chemistry of Substances taking part in Putrefaction and Antisepsis." By J. M. THOMSON, F.C.S. Four Lectures.

LECTURE IV.—MAY 23.—Special consideration of the chemical substances employed.—Antiseptics.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. J. M. Thomson, "The Chemistry of Substances taking part in Putrefaction and Antisepsis." (Lecture IV.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. Simms, "The Regent's-park Estate: its Origin and Development."

Geographical, University of London, Burlington-gardens, W., 2½ p.m. Annual Meeting.

British Architects, 9, Conduit-street, W., 8 p.m.

East India Association, Westminster Town-hall, S.W., 3½ p.m. General Sir Orfeur Cavenagh, "India and the Imperial Institute."

TUESDAY, MAY 24..SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Walter Crane, "The Importance of the Applied Arts and their Relation to Common Life."

Royal Institution, Albemarle-street, W., 5 p.m. Prof. Victor Horsley, "The Modern Physiology of the Brain, and its Relation to the Mind." (Lecture II.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Sir Frederick Abel, "Accidents in Mines." (Part I.)

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Dr. George Harley, "Comparison between the Recuperative Bodily Power of Man in Rude and in Highly Civilised Life." 2. Mr. G. L. Gomme, "The Evidence for Mr. McLennan's Theory of the Primitive Human Horde." 3. Mr. Samuel Gason, "The Dieyerie Tribe of South Australia." Communicated, with Notes, by Mr. G. J. Frazer.

Horticultural, South Kensington, S.W., 11 a.m. Scientific and Fruit and Floral Committees.

Cymmrodorion Society, Lonsdale-chambers, 27, Chancery-lane, W.C., 7½ p.m. Messrs. Isaac Foulkes and T. Marchant Williams, "The Life and Writings of Ceiriog."

Linnean, Burlington-house, W., 3 p.m. Anniversary.

Patent Agents, 19, Southampton-buildings, W.C., 3 p.m. Annual General Meeting. Discussion on Mr. Abel's paper on "German Patents," and on Mr. A. V. Newton's paper on "Compulsory Working."

WEDNESDAY, MAY 25...Geological, Burlington-house, W., 8 p.m. 1. Professor Joseph Prestwich, "Considerations on the Date, Duration, and Conditions of the Glacial Period with reference to the Antiquity of Man." 2. Mr. A. J. Jukes-Browne and Mr. W. Hill, on the "Lower Part of the Upper Cretaceous Series in West Suffolk and Norfolk." 3. Miss Jane Donald, "Notes on some Carboniferous Species of *Murchisoniæ* in our Public Museums."

Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

Parkes Museum of Hygiene, 74A, Margaret-street, W., 8 p.m. Mr. A. Winter Blyth, "Metropolitan Acts, Bye-Laws of Metropolitan Board of Works."

THURSDAY, MAY 26...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Anglo-Jewish Historical Exhibitions, Royal Albert-hall, Kensington, S.W., 8½ p.m. Mr. Walter Rye, "The Persecutions of the Jews."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture VI.)

Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. 1. Mr. Charles T. Fleetwood, "Underground Telegraphs." 2. Professors W. E. Ayrton and John Perry, "Driving a Dynamo with a very Short Belt."

FRIDAY, MAY 27 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. J. Berry White, "Indian Tea."

Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting, 9 p.m. Dr. E. G. Klein, "Etiology of Scarlet Fever."

Quekett Microscopical Club, University College, W.C., 8 p.m. 1. Mr. Underhill, "Spiders." 2. Mr. B. T. Lowne, "The Larva of *Musca vomitoria*."

Clinical, 53, Berners-street, W., 8½ p.m.

Browning, University College, W.C., 8 p.m. Prof. P. A. Barnett, "Browning's Casuistry."

SATURDAY, MAY 28. ..Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. S. P. Thompson, "Note on Transformers for Electric Distribution." 2. Mr. Shelford Bidwell, "Magnetic Torsion of Iron Wires." 3. Profs. W. E. Ayrton and J. Perry, "A Strain in a Beam fixed at both ends."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. W Hales, "Victorian Literature." (Lecture III.)

Journal of the Society of Arts.

No. 1,801. Vol. XXXV.

FRIDAY, MAY 27, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 15th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each. Not more than four tickets will be sold to any one member, and not more than 2,000 in all. When 2,000 have been disposed of, the issue will be stopped.

Tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter, a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, &c.) will be supplied. No refreshments can be obtained by purchase.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient. The members' invitations will be issued shortly. Visitors' tickets can be purchased from the present date.

Further particulars as to the arrangements will be announced in future numbers of the *Journal*.

HER MAJESTY'S JUBILEE.

The following is the list, complete to date, of subscriptions by members of the Society of Arts to the funds for the Imperial Institute —

				£	s.	d.
Amount previously published				2,127	0	6
James Bedford				1	1	0
*Mark Henry Blanchard, collected by—						
M. H. Blanchard, jun.	2	2	0			
S. G. Blanchard	0	10	6			
Other sums	2	6	0			
				4	18	6
Robert Capper (2nd donation)				1	1	0
Edward C. Cook				1	1	0
Major-General F. C. Cotton, C.S.I.				2	0	0
Edward R. Dale				0	10	6
,, ,, collected by him				0	3	0
John Gibson				5	0	0
Dr. C. Le Neve Foster				5	5	0
James Hopkinson				2	2	0
,, ,, collected by him—						
J. and J. Hopkinson	10	10	0			
John Hopkinson	2	2	0			
W. Wood	2	2	0			
A. Bennett	0	5	0			
				14	19	0
Edward Jones				1	1	0
Reginald Laurence				1	1	0
Captain P. M. Lawe				1	1	0
H. Wilkes Notman, F.R.G.S.				10	10	0
Charles P. Phillips				0	10	6
,, ,, collected by him				0	11	6
David S. Pigott				1	1	0
Henry D. Rhodes (2nd donation)				1	1	0
T. H. Sanderson				2	0	0
W. Cave Thomas, F.S.S.				2	2	0
Mrs. Tidman, collected by,				0	4	6
Samuel Tilley				5	5	0
William Watkins				10	0	0
				£2,201	10	0

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

CANTOR LECTURES.

Mr. J. M. THOMSON, F.C.S., delivered the fourth and last lecture of his course on "The Chemistry of Substances taking part in Putrefaction, and Antisepsis," on Monday evening, 23rd inst. A cordial vote of thanks was passed to the lecturer on the motion of the CHAIRMAN (Mr. Cobb, Treasurer of the Society), for his lectures.

The lectures will be printed in the *Journal* during the summer recess.

* Mr. Blanchard's own donation has already been announced.

APPLIED ART SECTION.

Tuesday, May 24, 1887; Prof. HUBERT HERKOMER, A.R.A., in the chair.

The paper read was "The Importance of the Applied Arts, and their Relation to Common Life." By WALTER CRANE.

The report of the meeting will be printed in next week's number of the *Journal*.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 17th, 1887; Sir RAWSON RAWSON, K.C.M.G., C.B., in the chair.

The CHAIRMAN said it was scarcely necessary, in an assembly composed chiefly of members of the Society of Arts, to make many observations in introducing the reader of the paper. Few who had visited the last Exhibition could fail to have been attracted by the West Indian Court, and having seen it, very few could have failed to inquire to whose efforts and to whose direction the beauty of that Court was due.. The answer was, it was their lecturer that evening. His reason for presiding was that he was the first person who introduced Sir Augustus into public life, now 20 years ago, when he had the opportunity in the Bahamas of recommending him as a member of the Legislative Council of that colony. He hoped that his having done so had helped to attract Sir Augustus Adderley's attention to subjects of this nature, and to stimulate his interest in the prosperity and social progress of that colony. The Bahamas, and the other West Indian Islands, owed much to Sir Augustus for his sacrifice of time, labour, and money to promote the satisfactory and very remarkable exhibition of the products of the West Indies in the last Exhibition. It was well to force upon public notice the condition of those islands, and what might possibly be their prospects for the future. There was a great lesson to be learnt from the paper about to be read, and perhaps he might be allowed to point out, as he probably would have to leave before the conclusion of the meeting, what those lessons appeared to be. He had had considerable knowledge and acquaintance with the West Indies, many of the last years of his public life having been spent there, but his acquaintance with sugar planting and the Negro Colonies commenced very early. It was more than forty years ago since he made the acquaintance of French emancipated negroes in the Mauritius. Afterwards he became acquainted with other French negroes in St. Lucia and Martinique, with Dutch negroes in the Cape Colony, with American negroes in the Bahamas, and in Barbadoes with thoroughly British negroes, so that for thirty years he had lived in Colonies in which the masses of people consisted of emancipated negroes. He never had any acquaintance with them before the emancipation, but had subsequently had great opportunities of forming an acquaintance with them, and the lesson which the paper, as well as his own experience taught, was that the great industry of the sugar colonies was threatened with destruction, and he did not see the likelihood of its recovering the position which it once occupied for a few years before and after the emancipation. Even if the present obstacle to its successful prosecution should be removed; if it were possible to find the means by any fiscal arrangements in our own country, or in the colonies, of meeting the difficulties presented by the system of bounty upon beet-root sugar, would not the West Indies be exposed to a still more difficult and dangerous competition with the cheaply produced sugar of the East Indies, of Northern Australia, and the islands of the Pacific? If it were possible to get rid of the bounties given by foreign nations to refiners, and to meet, by any arrangements of their own country, that unjust competition with colonial sugars, the consequence would be that the market would be flooded by the produce of the East, where labour was cheap and the facilities for producing sugar so great. Therefore he could not say that he looked to the probability of the resumption of the good old times for the West Indian planters, but he saw no reason why there might not be a great local prosperity and happiness in all these islands. When he first went to the Mauritius in 1844 (which was some years after the emancipation), most of the older habits of the people were still existing, and the planter life had not then ceased to be a happy, cheerful, and contented one. When an attempt was made to increase the productions of the islands, so as to to meet the incumbrances upon the estates, and to realise a profit for the planter who produced, and then a second profit for the commissioner in the islands who made advances, and a third to the capitalists at home who provided the local commissioner with means, then the difficulties began. It seemed there was still a future for the West India islands, though not in the direction which had formerly prevailed. That seemed to be the lesson to be derived from the paper and from his own experience; therefore it was of the greatest importance that they should learn how these islands could be cultivated with advantage and profit to those engaged in the cultivation, in other articles than sugar. Sir Augustus reviewed the different articles which could be cultivated with advantage in semi-tropical islands, and which had been cultivated more or less in several of the West Indian islands, and he gave an amount of information which, if recorded in

the annals of that Society, might be used hereafter by those who might find a happy home in those islands. Being constantly in communication with Barbadoes, he had received from the agricultural body there copies of their *Gazette*, in which they expressed the same sentiments. They pointed out all the difficulties which surrounded the continued cultivation of sugar as a profitable export, and enumerated a variety of products which might be introduced into the different islands with advantage, and of late they began to point out that these islands offered to the population of Barbadoes, and to the planters driven from their present cultivation of sugar, resources of a variety of kinds. As the profitable cultivation of sugar was driven out of these islands, he hoped that other cultivations might be introduced, and the West Indian islands, if they did not become an important source of revenue to residents in the United Kingdom, might afford a comfortable and profitable means of living to those who made them their home, and did not seek to make two or three profits out of the land. He thought that was the lesson to be derived from the paper, but of course it was not a very satisfactory prospect, and the meeting might view it otherwise.

The paper read was—

THE WEST INDIES AT THE COLONIAL AND INDIAN EXHIBITION, 1886.

By Sir Augustus Adderley, K.C.M.G.

The task before me this evening is by no means so light as perhaps many of you imagine. I have to speak to you not about one Colony only, as is usually the case with colonists who have the advantage of addressing you, but of an aggregation of Island Colonies, each of which has a separate history, both physical and antiquarian, as also a distinct political constitution and government. The West Indies, as you are no doubt aware, are a group of islands extending from the Bahamas off the coast of Florida, between 21° 42′, and 27.34 north latitude, and 72° 40′ and 79.5 west longitude, to Trinidad, at the mouth of the Orinoco, east of Venezuela, in 10.3 and 10° 50′ north latitude, 61.39 and 62° west longitude. Those belonging to Great Britain are the Bahamas, Trinidad, Jamaica, Barbadoes, Grenada, St. Vincent, St. Lucia, Tobago, Antigua, St. Kitt's, Montserrat, Dominica, and the Virgin Islands. It will be obvious to you all, that it is absolutely impossible for me, in the limited time at my disposal, to touch otherwise than lightly on the many distinct advantages of each individual island. I must perforce generalise, for otherwise this paper would assume proportions quite beyond your patience to listen to.

Combined, the West Indies represent an area of 100,000 square miles, inhabited by 1,500,000 British subjects—an extent of country equal to some of the largest Australian Colonies, to most of which they are superior in population. These facts will give you, I think, a fair idea of the importance of these ancient Colonies, which are, with the sole exception, I believe, of Newfoundland, the oldest of our immense possessions beyond the seas.

The Section.

When I had the honour of being selected to represent the British West Indian Colonies at the Colonial Exhibition, I determined that the exhibits of the aggregation of islands should be under one wide roof, whereby they eventually attracted far more attention than they otherwise would have done, and I am under great obligation to Sir Philip Cunliffe-Owen for apportioning to me so important a position at the Exhibition. Hitherto they had appeared separately in the various European Exhibitions, an island here, and an island there, with a disastrous result, scattered as were the exhibits in different nooks and corners, and frequently on that account lost sight of altogether. At South Kensington last year they really commanded great attention, and illustrated, very successfully, I venture to say, the truth of the adage that, " Union is strength."

The Section was about 400 feet in length, the decorations of a light and elegant Hispano-Moresque style. Each government had its own Court. Tropical plants of great beauty were included in the decorative scheme, and the *coup d'œil* from end to end was very pleasing and characteristic.

Picture Gallery.

A great attraction to the general public was the gallery. With the assistance of many esteemed friends, and the co-operation of Sir Graham Briggs and other collectors in the West Indies, I managed to render it interesting, as illustrating from the very earliest, in fact from prehistoric times, down to our own, the history of the Colonies in question. And here, I venture to suggest, opens out a vast field for historical and antiquarian research.

The glorious name of Columbus rises to the mind of all wherever the West Indies are mentioned. It is strange that the real history of this great man remains, like many other

biographies, to be written. Washington Irving, it is true, has done justice to the pioneer of Christianity and civilisation in America in his picturesque and graceful style, but Irving did not possess the opportunities of access to many manuscripts which are now open to historians. In point of fact he only used up material already known, and to be found in the Spanish public libraries. The immediate descendants of the discoverer, the Duke de Veragua of Madrid, most gracefully offered to lend me, for the gallery which I formed at the Exhibition, the originals of many manuscripts of Columbus and his followers. I declined his offer for various reasons, reasons which almost prompted me to refuse the loan of the Borgian map, lent by his Holiness Pope Leo XIII. This liberal Pope even offered to allow me to have copied for the Exhibition the series of nearly 600 letters and autographs of Columbus, of Pope Alexander VI., under whose pontificate the New World was discovered, of Ferdinand and Isabella, and other contemporaries, not one of which has yet been translated into English or printed, and which remain in the archives of the Vatican, now liberally thrown open to the investigation of students. The Venetian archives also, I am assured, contain much valuable material for the formation of a history of this kind, as well as do those of Genoa, the birthplace of Columbus, although this fact has been disputed from the time of his death, some writers stating that he was born in Corsica. The Marquis Staglieno of Genoa has, however, within the past few months set all doubts at rest on this subject, and lent to me a view of an ancient house in the parish of St. Stefano, near the gate of St. Andrea, in Genoa, in which, according to undoubted contemporary testimony only recently discovered, the illustrious navigator was born. Even the school where he went to learn his first lessons is now ascertained, and what his father paid for his education, a very small sum indeed, amounting to about 1d. per day of our money. These facts may appear trivial; they are not so indeed, for they form history, and serve to throw light on the career of one of its grandest figures.

I simply mention these few details to point out the existence of stores of historical material worthy of investigation. I may also add here, that the fine collection of stone implements and pottery, which was lent to me on this occasion, threw a singularly clear light on the real condition of the natives at the time of the discovery of the islands. As we approach nearer to our own period, we find in the Colonial archives much unpublished material, ready at hand, to illustrate periods of West Indian history, in which flourished the Buccaneers, the adventurers, and the great planters, forming a social system which, by the way, included both negro and white apprentice slavery, at once romantic and exciting, and introducing a luxurious, and not infrequently a dissolute, state of society, which has more than once attracted and engaged the pens of our greatest novelists. Before passing on to more important subjects in a purely material sense, I must once more allude to that curious historical document, the second Borgian Map, lent—through the kind offices of his Eminence Cardinal Manning—by the Pope, from the museum of the College of the Propaganda. It attracted immense attention, and deservedly so, being the second earliest complete record of what was known of the West Indies and of the American continent in 1525. It has been admirably reproduced on a diminished scale, a fact which I am sure all geographical students will hear with satisfaction, and I have supplied the various libraries of the islands with a copy. I wish once more to express my thanks, and those of West Indians, to the liberal-minded Leo XIII. for having allowed so precious a document to leave Rome, and to Cardinal Simeoni, the Secretary of the Propaganda, for permitting it to be reproduced. We must not forget that, a few years back, it was rigorously prohibited to copy this map; indeed, for fear of diminishing its value, it was rarely shown to strangers.

The West Indian section of the Exhibition was, however, by no means all artistic and historical. The sugars, the cocoas, coffees, fibres, barks, cereals, woods, medicinal herbs, and other products were shown to be equal, and in many instances superior, to those of any other part of the tropical world; many little known in Europe, and the uses of not a few wholly unknown or partially so.

Dr. Geo. Watt, whose knowledge of the economic resources of India is well-known to you, often visited us, being a great advocate for intercourse between the various departments, and as often as he came he gave us verbal testimony of his surprise and delight at our West Indian economic resources, which, comparatively speaking, are as limitless as those of India, and, I may add, of much the same character.

The Scenery.

This Institution in which I have the honour of appearing to-night is a Society of Arts, and I feel that before I proceed to the main subject of this paper, I must remind artists and lovers of nature that it is impossible in any other part of the world to surpass the beauty of some of the West Indian Islands. I assure you portions of the coast scenery of Jamaica, St. Lucia, Grenada, and Trinidad, rival, if they do not even surpass, that of the Riviera, of Genoa, or the still more beautiful coast line between Biarritz and Santander. The mountains, now rocky and stern, now richly clothed with varied tropical vegetation, rise out of the ocean, here abruptly, there gently, in a manner so picturesque as to awaken enthusiasm in all who for the first time behold them. The forest scenery cannot be described; no poet's imagination of Fairyland can compare with the surprising realities of a tropical forest, in which fern and palm, orchid and gorgeous creeper, and falling waters combine to form haunts for parrots and humming birds. Here, then, the artist will find never-ending subjects for his pencil and palette. The Bahamas, too, contain sylvan scenery of great beauty, which amply justifies the enthusiastic eulogiums of travellers.

History.

You are doubtless aware of the immense commercial prosperity enjoyed by the West Indies in the last century. It was so great that the mere mention of a West Indian planter conjured up visions of colossal riches and luxurious living. Unfortunately, this is by no means the case to-day. Straitened circumstances are the rule now where once wealth reigned supreme. Many are the causes of this decline, and although I heartily detest slavery as an institution, still, it is plain that its all too sudden suppression has been the first cause of evil and ruin to the West Indies. In point of fact, slavery was abolished before the negro was prepared to receive his freedom, and far too many coloured men, over-elated by their too sudden emancipation, began to believe that the august word "Liberty" meant "Idleness." It is a terrible pity that we did not, to a certain extent, follow the example of other countries, viz., carry out the process by slow degrees; it would have been, I am sure, far better for both races. It is, however, of no use crying over spilt milk; emancipated the coloured people had to be—it was the justice of God—but at the same time I know, as all who have ever been in the West Indies know, that it brought about the temporary ruin of the Colonies, and did material harm to those it was intended to benefit. A famous Jesuit missionary, in the 17th century, once quaintly observed that "God smiled much upon the West Indies at creation, but that the devil got hold of them soon after." They are beautiful, rich in resources, but they are not as prosperous as they ought to be. How is this prosperity to be increased—I might say, restored? The answer is a ready one: by the revival and increase of commercial prosperity. How is this to be effected? This is the problem to be solved.

In concluding this portion of my paper, I cannot forbear publicly expressing my high appreciation of the assistance given me by my able coadjutor, Mr. John McCarthy, assistant commissioner for Trinidad, to whom I am indebted for the compilation of a valuable report on the products which will give such information to commercial men and others in the Colonies. My sincere thanks are due to Dr. Watt, Messrs. Pasteur, Holmes, Jackson (of Kew Gardens), and Schlesinger, and the late M. Eugene Rimmel, who, with spontaneous kindness and generous interest in the welfare of the Colonies, contributed in a disinterested manner the result of their studies. I will now refer to some of the products.

Sugar.

Sugar, as the main staple, has become so much reduced in value that it is a serious question whether cultivation by the same proprietors can be continued for long unless some remedy can be found to counterbalance the effect of the European bounty system upon our unsubsidised cane-sugar production. The extension to the British West Indies of the most favoured nation clause in existing treaties with the United States, is also of much importance.

The bounty system is gradually forcing the production of sugar out of its natural channel. This is evident by the fact that 2,500,000 tons of beet sugar are now produced, all under the bounty system, while the production of the unsubsidised sugar is reduced to 2,000,000 of tons, all the product of the sugar cane. This is free trade with a vengeance, and the serious part of it is that we are ruining our own industries to create a monopoly for foreign countries.

A great responsibility rests on England for

all these troubles—troubles which, fortunately perhaps for the West Indies, are extending to the home industries. A serious effort should be made to stop the storm of discontent which is slowly and surely spreading throughout England and in the West India Colonies. "A stitch in time saves nine;" unfair trading ought no longer to be tolerated by our rulers or people.

The sugar supply of the world is mostly derived from the sugar-cane, from beet-root, and to a small extent from the sugar-maple and other vegetable sources.

The two largest consuming countries are England and the United States, the latter country slightly in excess of the former—say 1,300,000 tons for United States, as against 1,200,000 tons for England.

All the sugars at the Exhibition from the West Indies were produced from the sugar-cane, and the approximate annual production is about 280,000 tons, if we include British Guiana.

Mr. Lubbock thus reports on these:—

"The sugars exhibited by these Colonies are various, and include the brown Muscovado, so much liked by our refiners and those of the United States; fine yellow Muscovado, suited for grocery purposes, which chiefly come from Barbadoes; the well-known bright yellow crystallised, mostly from Demerara, but now also largely produced in Trinidad, Barbadoes, and some of the other islands; and finally, white crystals. These sugars are all eminently suitable for the English market, except the white crystals, which cannot compete with those of our refiners, not on account of any real inferiority, but from the impossibility of producing, at a cost which would be profitable, that sparkling appearance which our refiners, working on a large scale, can produce at a merely trifling expense."

Raw cane-sugars are most agreeable to the taste, whilst a similar kind of beet-sugar is most disagreeable in taste and smell, which adjuncts are only to be eliminated by a refining process. Consumers should note this. Kidney diseases are also said to be developed where beet-root sugar is consumed.

Cocoa.

Cocoa, or cacao, is the prepared seed of a tree originally discovered in the tropical parts of America. Its botanical name is *Theobroma cacao*. The seed is enclosed in a long pod, varying from 7 to 10 inches.

The plants with pods on were exhibited in the Trinidad Court. Its value depends a good deal upon the treatment of the seed.

Mr. Henry Pasteur gives the following particulars of cocoa.

Cocoa, unlike coffee, requires no expensive machinery for its preparation; wooden boxes for the fermentation, and wooden platforms for the drying, covered with a moveable shed, are all that is wanted; and it is strange that such a large proportion of our West India Colonies should ship their produce without using these simple means of curing properly.

There are several modes used in our Colonies for curing cocoa, to render it fit for shipment to the consuming countries. The simplest method is to take the pod, and strip it from the seed, wash the seed, and then dry it in the sun. The better plan is to place a quantity of seed—still enveloped in its copious, sweetish pulp—in boxes closely covered, and to allow it to ferment for some days; it is then washed free of the mucilage that is still left on the surface, and after that picked and dried. A further improvement has been made upon this treatment by refraining from the washing away of the mucilage after the fermentation has taken place, and allowing it to dry upon the shell which encloses the seed. This process is coming more generally into use, both in Trinidad and Grenada.

Cocoa requires a rich, deep, moist soil, and seems to flourish best at a low elevation. The rainfall in Trinidad averages 66 inches annually, and the finest cocoa is grown at an elevation of from 60 to 200 feet above the sea-level; the difficulty is in finding land and climate approaching to these conditions. The planter, finding the position and soil suitable for the enterprise, and willing to be patient until his cocoa tree has arrived at maturity, will find in the fourth year results sufficient to pay him.

The world's production of cocoa has been variously estimated at 100,000,000 lbs. to 120,000,000, of which our English Colonies furnish quite 25,000,000 lbs., which mostly find their way to London. In Trinidad only, there is a competition on the part of the United States of America and France for the inferior qualities, which are sold at the shipping port, all the finer estate cocoa being sent here.

The home consumption of Great Britain shows a steady increase of about 750,000 lbs. yearly, the consumption, in 1885, being 14,500,000 lbs. The English Government has taken Trinidad and Grenada cocoa for the Navy during the last seven or eight years, in preference to other sorts.

The largest growing country is Ecuador, of which the produce is known in the market under the name of Guayaquil cocoa, and the extent of its crop, as well as that of the Brazilian province of Para, have a marked influence on the prices realised for all kinds of cocoa. Those crops vary considerably from year to year in extent, Guayaquil more especially. In our own Colonies, Trinidad shows an increase, the crop of 1885 amounting to 14,000,000 lbs.; but in Grenada, St. Lucia, Dominica, and Jamaica, the quantity produced the last year or two does not seem to have varied. In seeking for a reason for the want of the extension of planting and cultivation to meet the increase of consumption, it may perhaps be found in the initial expense in the forming of new plantations. The trees do not yield tribute sufficiently remunerative until the fourth year. This waiting for results has no doubt prevented enterprise.

The following is from my special report:—In making a report upon the value and quality of West India cocoa, I have, in the first place, to take into consideration the ultimate destination to which the varieties of cocoa go. In the manufacture in Great Britain during the last fifteen years, an important alteration has taken place in the mode in which it is distributed for consumption. A few large manufacturers have taken the trade out of the hands of the general wholesale dealer, who used to have, each his own way, a preparation of cocoa, such as what is called "nibs," "flake," "soluble," &c. This individual treatment has been mostly superseded by large manufacturers, who, by a specific and scientific treatment of the article, have introduced preparations superior to those made by the efforts of the dealers. In a measure this partial monopoly has been brought about by their taking care to make known to the public their several productions; the public, when wanting cocoa or chocolate, asking for the "advertised article."

As regards Trinidad cocoa, in the curing of it for the English manufacturer, I should hardly like to propose any alteration, but in view of the increasing production, which I should hope, judging from the very permanent value established for it, will induce planters still to go on freely cultivating it. Consideration must be given to the value of cocoa in the opinion of German and French buyers. The Continental buyers always seek after colour (the same thing rules them in their purchases of coffee). The English buyer, as a rule, goes for the intrinsic quality and proved flavour. The Continental buyer likes large size, the shell to be red, inside kernel to be evenly fermented, and a light reddish-brown or chocolate colour. It may be that these things constitute a certain indication of quality.

The individual samples shown in the Trinidad Court were all well known marks, and produce of estates to which the buyers in the London market have established a relative value according to their merit. The higher priced ones are lifted out of the reach of the Continental buyer by the English manufacturers' determination to keep them for their own use. With regard to the extraordinary and peculiar level to which a number of these estates and marks have been kept in price, I may mention that the greater proportion is bought by one firm, and the only disturbance of these prices is the competition for a portion of these from the other English manufacturers. This competition has been mostly for fine qualities, avoiding the too highly fermented samples. Of the 48 specimens exhibited, prices realised show the buyers' estimation, viz., 94s. to 96s. per cwt.

On the first 15 samples there was to be observed a bloom (like the bloom on the plum) on most of them; this I have always considered an indication of fine quality. It may arise from a slight secondary fermentation, and the superior character of the pulp, dried upon the shell, imparting to the cocoa a finer flavour. I believe the qualities possessed by the pulp influence the flavour of all unwashed cocoa.

From Granada we had ten samples, from eight small estates, of the best character. Considering that their production is the next largest to Trinidad of our Colonial growth, it is a pity that it was not better represented.

Dominica sent us a number of very attractive samples, sound in condition, mostly washed, and presented a bright pale red and red shell. This cocoa is larger and more even in size than Granada, but the flavour of the part fermented and unfermented is slightly bitter; but it is evidently worth trying to improve the curing.

The remaining sample, representing the crop of 1884, mixed, fermented, present value about 60s. Jamaica cocoa is a very thin bean of poor growth and quality; no care seems to have been taken in its preparation. Unless better seed can be planted, there seems no hope of any great improvement taking place in its production, as the taste and flavour of the nut

is now very "bitter and acrid." It is apparently the most "inferior" of the cocoa trees. Values from 70s. to 54s. per cwt.

Barbadoes.—One, red, part fermented, value 68s.

The exhibits from Jamaica, Dominica, and St. Vincent, nearly all cocoa that had been washed and dried, unfermented, partly fermented, and out of the whole number perhaps only three fully fermented, did not represent the cocoa as delivered in London. I have come to the conclusion that the washing process—the contact of water, notwithstanding the attempted drying—seems to leave a moisture, which is thrown out on the surface of the shell, entirely altering its appearance from the bright pale red and red samples exhibited. When offered in the market here, they present a grey and greyish-red appearance, the fruit often being mouldy, the result probably of packing in bulk and transport.

The exhibit of cocoa butter or fat had a significance and interest on account of its representing a new process of manufacturing cocoa, the admixture of farina and other substances not being followed, and the fat extracted, so that it is likely to largely increase the quantity of cocoa used in the manufacture of the prepared article as used by the public. It is also valuable for medicinal purposes for making ointments, &c., in consequence of its not turning rancid. The deliveries of cocoa for consumption—say, the 14,000,000 lbs. of 1885—would probably represent in weight over 20,000,000 lbs. of cocoa when manufactured. I may mention that, at a cocoa stall, we sold pure unadulterated cocoa, the idea being that for the working man it is an important beverage, more nutritious and cheaper than the adulterated article.

Coffee.

The following is from a memorandum given me by Mr. H. Pasteur:—The total production of coffee in the world is roughly estimated at about 600,000 to 650,000 tons, of which Brazil alone produces between 340,000 and 380,000 tons, and Java 60,000 to 90,000 tons, the proportion of British-grown coffee being only about 35,000 tons, of which India contributes 15,000 to 18,000 tons, Ceylon 10,000 to 12,000 tons, and Jamaica 4,000 to 5,000 tons. Although numerically very small, the productions of our Colonies and of India occupy the front rank owing to their excellence. Nowhere is finer coffee grown than in India and Jamaica, and its value, as well as that of Ceylon, is firmly established above that of all other kinds, even of Mocha, which at one time stood above all others.

Jamaica.—Coffee is grown in almost every one of the West India Islands, but Jamaica is the only one where the cultivation is carried out on an extensive scale, the quantity exported in 1885 amounting to 80,600 cwt., and occupying the third rank in value of the products exported from the island. From 8,000 to 10,000 cwt. are produced annually on plantations situated on the high lands of the Blue Mountains, which have long been known as one of the finest coffee-growing districts in the world, thanks to a fine rich soil and a favourable climate, combined with all the care and intelligence which the means of European planters can command. The coffee from those favoured localities is all consumed in this country, and realises almost the highest prices in the market — say, from 90s. to 140s. per cwt. The remaining 60,000 to 70,000 cwt. are grown in various parts of the island; some in the Manchester district is of medium quality and well prepared, but the greater portion is cultivated in small patches or gardens, by settlers and small proprietors who do not possess the knowledge or the means of preparing their crops properly; or in the low country, where an inferior quality is raised; hence the great difference in prices between "fine mountain" and the ordinary Jamaica. The want of proper curing establishments, is much felt in many parts; it is probable, too, that the plants are not raised from good seed, and that better cultivation and manuring are needed. But even this will not suffice to ensure the good quality of the crop, unless due attention is paid to picking at the right moment, and to immediate pulping and thorough drying of the parchment. This should ensure the proper colour, but, in the absence of the necessary appliances, the planter would best consult his interest by sending his parchment to be peeled, &c., at the nearest works, or better still, by shipping it to London for treatment. Ordinary Jamaica coffee is now selling here at from 50s. to 53s. per cwt. and there is every reason to believe that, with better care in picking and curing, and with quick despatch of the parchment to London, the grower might obtain from 10s. to 12s. per cwt. more than he does at present. There does not seem to be any good reason why, in a country where the highest priced coffee is grown, the bulk of the production

should rank on a par with common Brazil, or the lowest known qualities.

The extensive planting of the Liberian variety, which appears to be going on in Jamaica and other places, will most probably lead to disappointment; the quality is so poor, so deficient in strength and aroma, and so little appreciated in the home markets, that any material increase in the supply must inevitably lead to a lower range of prices, which will fail to repay the outlay.

The Jamaica plantations appear to have been so far quite free from leaf-disease, flies, or other enemies of the coffee tree, and there is an abundance of forest lands of proper elevation in the St. Ann and Clarendon districts, and the northern slopes of the Blue Mountains, suitable for extending the cultivation of the finer classes, which ought to give handsome returns for the capital so invested.

Of the sixty-nine samples exhibited in the Jamaica Court, sixteen are parchment and cherry; nine from the finest estates are worth from 110s. to 140s. per cwt., averaging 120s. to 125s.; eight average 90s. per cwt.; eight more 75s. per cwt.; eight are worth from 54s. to 65s.; and two about 47s. There are also twelve samples of Peaberry from 70s. for the lowest to 105s. for the best; and two samples of Liberian worth 56s. and 50s. per cwt.

St. Kitts, Antigua, and Montserrat sent coffee, good quality to ordinary, value 60s. to 50s. per cwt.

Dominica.—Coffee was, at the beginning of the present century, the leading article of export from this island, and it was then considered one of the best kinds produced in the West Indies. The trees, however, were attacked, some forty years ago, by an insect blight, which spread devastation among the plantations, and destroyed the greater portion of them, so reducing the production that at the present time it is hardly equal to the consumption of the island. Cultivation is now reviving to some extent, and it appears that the blight, although still in existence, is comparatively harmless at high elevations. The Liberian variety has also been introduced. There is an abundance of fine forest land and rich soil on the slopes of the bold mountains which cover the country, with plenty of moisture, conditions which are eminently favourable to the growth of coffee.

Of the ten samples exhibited, two are of very small, hard, heavy, greenish bean, worth about 70s. per cwt., one pale native kind 50s. one Liberian 52s.; the remainder are of a good size, greenish to rather good green colour, and if properly picked and prepared would be worth from 63s. to 76s. per cwt.

Barbadoes.—One sample, ordinary pale uneven native sort, 52s., and one sample of very well prepared good bluish plantation, of even size, though a little rough, 80s. per cwt.

Grenada.—One sample, large pale greenish, useful quality, 54s.

Tobago.—Two samples of dull greenish and and brownish Creole coffee, not sized, but good of its kind, 56s. to 58s. per cwt.

Trinidad.—Ten samples are exhibited. Two of them consist of very common dull brown and red badly prepared coffee, worth 47s.; four are Creole, or pale native kind, of a useful quality, ranging in value from 52s. to 54s.; the others are better, and, with more care in their preparation, might be turned into good coffee, worth probably 60s. or 70s.; but being imperfectly picked, and of a brownish colour, their value is reduced to 58s. to 60s. per cwt.

There appears to be a good deal of land suitable for opening into coffee gardens or plantations, and planting has been carried on lately on a larger scale. It is to be hoped that the botanic gardens which supply plants from their nurseries will endeavour to provide none but those grown from the best seed of *Coffea arabica*, which can easily be procured from Jamaica or from New Grenada. In an island where the cultivation and preparation of cocoa has been brought to such a degree of perfection, there ought to be no lack of skilled labour to prepare coffee much better than is apparent from the samples exhibited. The shape and size of the berries show that the soil and climate are favourable, and that it is only labour, care, and skill which are required to give the coffee its proper value.

In concluding this report, it is difficult to avoid alluding to the extraordinary treatment to which coffee is subjected at the hands of the British Government. Were the same amount of fair play and protection against fraud extended to it as is accorded to tea, it is probable that the greater portion of the 35,000 tons of British-grown coffee would be retained for home consumption, instead of a paltry 14,000 tons, or at the rate of about 15 ozs. per head of population per annum, against $2\frac{3}{4}$ lbs. per head in France, 5 lbs. in Germany, $7\frac{3}{4}$ lbs. in the United States, &c. It would almost seem as if the Treasury, which is directly responsible for the legislation on the subject, was

bent upon discouraging, by every means in its power, the use of one of the most delicious and beneficent of the non-alcoholic drinks, by the sanction which it gives to its adulteration with any vegetable matter; it is impossible to recognise coffee in the wretched mixtures which are sold in every shop and store, or in the thick, dark liquid which is served under that name in many of the coffee palaces and temperance houses throughout the kingdom. No wonder that consumption decreases year by year, not of coffee alone, but even of chicory and mixtures. The Local Government Board and the Board of H.M.'s Customs join, in their annual reports, in ascribing the diminishing revenue from coffee and chicory to adulteration, and in condemning the present legislation on the subject. Surely those who are engaged in the cultivation, importation, and trading in coffee, ought to combine to make an effort to obtain redress for what is acknowledged almost on all hands to be a crying injustice.

TOBACCO.

St. Lucia Tobacco.—From the size and development of the leaf it would seem that the soil might be made suitable to the growth of tobacco, provided great care and attention were paid to the choice of the seed and the selection of the site. The sample exhibited indicates that, with careful cultivation, very saleable tobacco might be produced.

Trinidad Tobacco is too thin for English use. The sample grown by J. J. St. Hill wants body to produce more elasticity in the leaf. The sample grown by C. Fabian and Son has more body, but from the size of its leaf would only be suitable for fillers.

The tobacco used in the manufacture of segars from Barbadoes and Antigua, is hardly (in comparison with segar tobaccos of other growths) suitable for anything but very common descriptions, and limited to local consumption only. The specimens from Jamaica and Trinidad exhibit better material and workmanship, and may be classed as good medium sorts, but, as such, their production can only have a local interest. The segar manufacturers in England, and in Europe generally, have at their command a great variety of the best growths which the world supplies, and of the best skilled labour. A genuine import trade in anything but certain specialities, such as finest Havana and Manilla segars, cannot be looked for as possible in England or the Continent, and, apart from the disadvantage of differential duties which some imports would have to encounter, even the best specimens from these islands could not compete in quality or economy with ordinary medium goods manufactured here and elsewhere. I may mention, however, in spite of this report, that Trinidad segars sold well at the Exhibition, as did those of the Bahamas, made, however, in the latter case, from Cuba leaf.

In referring to these Bahamas manufactured segars, which are equal to the finest Havana, I may here give an illustration of the shrewdness of our American cousins in all matters connected with the introduction of new industries into any portion of their possessions.

Their tariff puts a very heavy duty on segars from Cuba, whilst the leaf tobacco is admitted at a much lower duty. As a result, Key West, an island off the Florida coast, belonging to the United States, has monopolised all the segar trade of the Cubans with the United States. A large number of Cubans have settled and established factories there; the population has increased twenty times during the last ten years, land has been bought up, and more enhanced in value, and a most thriving community now exists. Cubans are ready to do the same work for Nassau, if some concession on the duty could be made by the Home Government, on British Colonial manufactured segars imported into England.

I fear it is hopeless to expect this, but with the bounty system in foreign countries continued for long, the time will come when we shall have to win back our prosperity by such a process, and up-hill work will it be.

There are good grounds for the conclusion that many of our West Indian Colonies possess the capabilities necessary for the successful cultivation of marketable tobaccos, and even, in some instances, of the higher and more costly classes, suitable for the manufacture of segars.

The tobacco leaf, when grown in countries far apart from each other, varies greatly in character and appearance, and at least in as great a degree as any other vegetable production. This variety and divergence may be partly owing to the selective agency of the cultivators, but the sole effect of soil and climate seems, more than any other cause, to impress a certain definite character on the respective growth of each country. For example, certain southern parts of the United States, in which tobacco is so largely and sucessfully cultivated, can only produce the

heavy sorts suitable for smoking in the pipe; and the States, notwithstanding the variety of soil and climate, and the extent of territory at their command, have to draw their supply of the finer sorts from distant and foreign sources.

I venture to point to the obvious conclusion that the acquisition of a true knowledge of the special class of tobacco naturally produced in their various localities is the first of all necessary. It would be a waste of effort to attempt the growth of any other variety, or to prepare it for a purpose to which it is not adapted, whether for segars, the pipe, or for cigarettes. It may also be mentioned that, though tobacco of a sort will grow almost anywhere, it is only in special limited localities, even in the countries which have proved well adapted for its cultivation, that the superior and paying classes of each sort can alone be produced. This points to the necessity of a careful and experimental selection of site, and of due observation of results, guided, if possible, by a knowledge of the article itself, a knowledge of the constituents of soils, and of the requirements of the world's markets.

Sponges.

The exhibits of this useful article were chiefly from the Bahamas.

There are many varieties; the principal in order of their value are the sheepwool, white reef, Abaco velvet, dark reef, boat, hardhead, grass, yellow, and glove, principally used for mechanical, surgical, and bathing purposes. The best description of Bahamas is inferior to those of the Mediterranean, although the sheepwool, for bathing purposes, is stronger in texture and more durable than the Mediterranean kind, but not so good looking. The exports amount to £60,000 annually.

The bulk of the Bahamas sponge is taken by the United States and part by France. Sponges were first discovered in the Bahamas by Sir John Lees, the father of the present Governor of Barbadoes.

A question in my mind is whether the existing sponge beds, if continually fished, as at present, are not likely to be exhausted, and whether, to guard against this, it would not be possible to institute a periodical close time for the protection during the reproductive season, or, at all events, a close time in certain areas which have been fished for years, to act as nurseries, and allow the germs or embryos to be distributed to the other waters.

The importation of the germs of the finer kinds of the Mediterranean sponge is well worth the effort. Success, which is more than probable, would enormously increase the value of the fisheries.

I understand sponges have been successfully cultivated by cuttings, both in Florida and by Professor Schmidt and Mr. Gregor Buccich in the Adriatic Sea. I believe these experiments were only stopped by the hostility of the fishermen.

Fibres.

Of these raw materials, the West Indies have, until the present time, contributed little—that there is scope for a large trade few can doubt.

In the Indian Section, where the flora is so similar to the West Indies, the extensive collection of raw materials have been submitted to an exhaustive examination by Mr. C. F. Cross and others. Their report contains full accounts of the scientific methods pursued, and should be studied by all who are interested in this subject.

Mr. Cross has kindly made the following report for me:—

Monocotyledonous Fibre.—In this are included all the lower grades of textile fibre, used for ropes and coarser twines, obtained from plants of the aloe and plantain orders. Not only is the climate of the West Indies especially adapted to the production of these in full luxuriance, but many of them grow under conditions the least favourable to other forms of vegetation—*i.e.*, on barren or rocky soils. Such considerations, or a collateral purpose of cultivation, for fruit or seed, as in the case of the banana, may determine an advantageous cultivation, by outweighing the disadvantages of low yield of fibre and difficulty of isolation.

Taking this latter case, by reason of its importance, first: What prospect is there of working up the refuse banana stalks into a paper material, to sell in European markets at a remunerative price?

Mr. Morris has dealt with the question of preliminary treatment of the stems in his paper read before the Institute of Jamaica, February, 1884, and I can, from my point of view, fully endorse what he says. But in my opinion, the treatment he recommends, though perfectly good as far as it goes, must be supplemented; the material must be so prepared as to yield to the paper maker here not 30 per cent., but 50 to 60 per cent., and to sell at about £8 a ton. So to concentrate the substance, a pro-

cess of boiling is necessary, with the addition of a cheap base, such as lime or even chalk, to neutralise the acids of the plant, and allow of boiling in iron vessels. Having thus got rid of soluble matters, the material must be crushed or stamped, and washed, to remove cellular matter, and lastly, dried and press-packed. The chief point to consider is the probable yield of such a product. Mr. C. M. King, who has been associated with me in this Exhibition work, during his residence in Jamaica, investigated the yield obtained by treatment with the Ekman process, which he found 1½ per cent. on the green stems. Such a product was, of course, much more highly "cleaned" than the one we have been considering. Estimating for the difference, the yield of paper-making material on the above treatment may be taken at, say, 2 per cent. On 100 tons of green stems, therefore, £16 represents the trading basis, *i.e.*, the sum out of which all charges and the profits are to be met.

There is, as far as I can see, nothing further to be said on this vexed question: it should be solved by a definitive trial, and it should be borne in mind that such an enterprise, established on the basis of a satisfactory issue of the trial, could only be successfully carried on by a eo-operative union of those interested.

Coming now to the higher group, *i.e.*, the textile fibres obtainable from Monocotyledons, the most expedient course would be to select two fibres, one coarse and one fine—say, for instance, *Fourcroya gigantea* and *Acrocomia* (the *Gru-gru* fibre exhibited in the St. Vincent Court). These fibres have proved themselves, on the results of investigation of the prepared specimens, to be the most valuable. All that is wanted for a commercial estimate is the cost of preparation in a satisfactory condition. This will very much depend upon the yield on the green substance, and the process adopted for obtaining the fibre; upon the selection of a machine for the purpose I am not prepared to advise. I should recommend a preliminary steeping of the green substance, and with the addition of an anti-ferment, such as sulphite of soda, or preferably, sulphite of lime, in virtue of its relative cheapness. I base this recommendation upon the recognised advantages of the steep, together with the common experience of the dangers attending a fermentation which is difficult to control.

Dicotyledonous Fibres.—Of these we may also distinguish two grades, the lower available for paper-making, the higher for textiles. Of the former I selected for investigation from amongst those exhibited the sugar-bark fibre, *Malva viscus*, *Malva sylvestris*, and *Daphnopsis*, all in the Jamaica Court. These give from 58 to 63 per cent. of cellulose, and are easily treated. I should advise the preparation of further and larger specimens, so as to determine the cost of production on the one hand, and selling value on the other; for the latter a paper-making trial is necessary. Of the above three I should prefer to give the preference to the *Malva*, on account of the superior length of its ultimate fibre.

(*b*) *Textiles.*—Of the jute class, the *Mahoe* is worthy of special notice; I have given in my official report the results of the analysis of the specimens exhibited. I am of opinion that this fibre is capable of considerable improvement in quality upon that exhibited. It would be well to look into this matter from the botanical point of view. By modifying the conditions of growth, introducing such artificial restrictions as are known to contribute to the development and improvement of fibre, doubtless a much superior product can be obtained. Secondly, I would call attention to plants of the species *Sida*, mentioned in Mr. Morris's report above mentioned. In the Indian and Queensland Sections there are excellent specimens exhibited of the best fibre of this plant. It is of the jute class, but in all respects superior. The probable future of this fibre is fully discussed in my official report. Without going over this discussion again, I may call attention to the general conclusion that it is a fibre destined to displace jute in many of its applications.

The separation of the fibre is a simple process, requiring only a preliminary retting treatment; and although no specimens were exhibited in the West Indian Section, I think it, nevertheless, a matter of interest to the authorities as a probable item in future commerce in fibrous raw materials.

In the higher grade textiles, *Rhea*, or *Ramie*, is the only fibre which appears to adapt itself to the particular conditions, agricultural and otherwise, of West Indian planting. Upon this fibre there is nothing that I can say beyond expressing my opinion that the estimates which have been formed of its capabilities are, in many cases, inflated, and the line of treatment at present adopted for isolating the fibre (Frémy-Urbain process) is not altogether sound. The treatment I should recommend is to strip the stems, and boil the bark strips in a solution of sulphite of

soda, then wash, to thoroughly free from all non-fibrous matter. This chemical is now prepared in a highly concentrated form by Messrs. Gaskell, Deacon, and Co., at so low a rate (£7 a ton) as to be well within the range of a number of applications, formerly prohibited by excessive cost. Its employment upon vegetable fibrous materials, in preference to all other alkaline reagents, for the purposes of purification, is justified, not only on theoretical gronnds but by the results of processes now working on the large scale.

In conclusion, I would point out that there are now generally recognised methods of investigating fibres and fibrous materials which effectually solve all problems both of treatment and application, without recourse to the uncertain process of what is termed practical experience. At least, therefore, in the early stages of development, the co-operation of scientific investigation will be found the most effectual aid to progress. Should any of the Government chemists in the several islands require special information as to these methods, I shall be glad to afford whatever it is in my power to do.

Cotton.

Of this product the West Indies at one time supplied the largest quantity. The samples from the Bahamas ran most regularly, and were quite up to American growths of the same grades.

Attention might be turned to it again. The bug, of course, is a great enemy, and labour is another difficulty. The association, however, of cotton with slavery is now a thing of the past, and on the principle of not putting too many eggs in one basket, this useful product should be more grown.

Red or Nankeen Cotton.

Great attention has been given to this, and large quantities could be sold at from 5½d. to 6d. per lb., and if, as has been stated, the bug does not attack this kind of cotton, it ought to well repay the growers. Not only would there be a great demand for hosiery, but also for clothing for the troops in India. Some of the samples sent have been worked up into cloth, and have been submitted to the India-office and War-office for use as Kharki clothing for the troops. The report is favourable, and the colour stands well. The hosiery is excellent, soft, warm, and a nice natural colour.

Large tracts should be at once planted out, and, as uniformity of colour is of very great importance, care should be taken to avoid mixture and any other treatment that would be likely to cause a variation of colour.

Medicinal Plants.

I may mention medicinal plants, but it would be obviously impossible to review the enormous mass of exhibits under this head in a paper like this. They are amply detailed in my report on products. Dr. B. H. Paul's report to the Royal Commission is well worth perusal. Of cinchona from Jamaica he says:—Some very fine samples of cultivated cinchona bark were also shown in the Jamaica Court. The growth of cinchonas in the island was introduced experimentally by Government in 1866, and upwards of 150 acres are now under cultivation. Some of the bark grown in Jamaica is of very good quality.

The samples of Jamaica-grown cinchona bark received from the Jamaica Court give the following results, on analysis by Dr. B. H. Paul:—

	Officinalis quill. per cent.	Hybrid quill. per cent.	Succirubra renewed. per cent.
Quinine	3·86	3·17	2·97
Quinidine	Trace	Trace	0·51
Cinchonidine........	0·67	1·95	1·50
Cinchonine	0·05	0·47	2·30
Amorphous alkaloid..	0·26	0·85	1·06
Total alkaloid	4·84	6·44	8·34

Kola Nut.

The nut of the *Cola acuminata* (also called *Sterculia acuminata*, Gourou, Ombéné, Nangoué, Kokkorokou, Female Kola, Bissy-Bissy, and Coorooah), is destined to play an important part, both in commerce and medicine. In an exhaustive paper by Professors Heckel and Schlagdenhauffen, the eminent French chemists, kola is ranked equal to tea, coffee, matè, and cocoa. They found the nut to contain over 2 per cent. of caffeine, as much, and, in good parcels, rather more than is contained in coffee, besides about 36 per cent. of sugar and starch, and other important constituents which determine the use of the nut as a food and medicine.

The properties claimed for the nut are: for checking dysentery and diarrhœa, more especially when contracted in the tropics, many cases of Cochin-China diarrhœa having been entirely cured; for restoring impaired digestion; for nervous debility arising from the group of symptoms known professionally as neurasthenia, which consists of chronic excruciating headaches, loss of appetite, costiveness, exhaustion, &c.; for restoring the system when under influence of alcohol, and to prevent a return to the habit of drinking. The latter property is claimed for it in "New Commercial Plants and Drugs," where it is related that a Jamaica planter treated the negroes with the fresh nut when in a state of drunkenness; the good effect is probably due to the caffeine in the nut combined with the tonic action of the other constituents upon the nervous system; the statement that after the use of the kola nut the patient does not return to drink is, no doubt, explained by its stimulating property inducing so healthy an action upon the system that the want or craving for spirit is not felt.

The nut is ground and mixed with coffee, much to the gain of the latter in so far as stimulating effects are concerned, and for this purpose the price at which the nuts are obtainable make a very advantageous pecuniary difference to the dealer. When the nut contains over 2 per cent. of caffeine, and can be had at 5d. or 6d. per lb. it pays to extract caffeine from them instead of from coffee. They form, also, the basis of a patented aërated drink and beer. Ground and made into a paste, the Kola nut is now coming to the front as a beverage. The nut has the singular property of clarifying beer and spirits, and rendering the foulest water healthful; this action is due to the gum it contains. The tree, which stands from thirty to sixty feet high, resembling in general aspect the chestnut, frequents the moist hot woods of Western Africa, and has been successfully introduced into the East and West Indies, Seychelles, Ceylon, Mauritius, Zanzibar, Guadaloupe, Cayenne, Cochin China, and the Gaboon. It likes low, moist lands, at the level of the sea, or a little above, but it does not do well above 800 to 900 feet. It yields its first crop at the age of five years, and is in full bearing at ten years; a single tree then yields an average of 120 lbs. of seed annually, the flowering being continuous after maturity. There are two crops—in October or November, and in May or June. The seeds are gathered when the dehiscence of the capsule takes place. They should be carefully freed from the husk and episperm (all damaged and worm-eaten ones being removed), and if it is desired to ship them in a fresh state, it should be done in baskets lined with some large thick leaves. Fresh nuts are generally sold at the rate of 40s. to 50s. per cwt., but the market for fresh seed is very limited.

To dry the seed, so as to lose as little weight and properties as possible, they should be placed in layers on trays in the shade, where there is plenty of air, and left till perfectly brown and dry. So treated, they will have a fine appearance, being neither blackened or shrivelled, which is the case when allowed to dry in the sun, when they lose much in weight by a too rapid exhaustion of the moisture.

For many purposes, slow drying is not absolutely necessary, for instance in cases where the nuts are consumed in a powdered state; but every care must be taken to prevent their becoming mouldy or worm-eaten; a parcel of nuts with the faintest odour of mustiness would be discarded by manufacturers. The prices vary a good deal according to supplies and quality. A nut with a good appearance may fetch as much as 70s. to 90s. per cwt., whereas small shrivelled-up nuts have sold for 20s. to 35s.

This tree is certainly worthy of a more extensive cultivation, and would yield a handsome return to those having low-lying lands unfit for other products. The demand would greatly increase if manufacturers were assured of a continuous supply, enabling them to introduce permanent articles, which they are now precluded from doing for want of reliance upon the present shippers. A very useful little pamphlet on the medicinal and other drugs has been published by Mr. E. M. Holmes, curator of the museum of the Pharmaceutical Society.

Starches.

Many of these on examination have proved suitable for sizing and finishing of textile fabrics.

Fruit

I need not discuss. West Indians are alive to its importance. The rapidly increasing population of the American continent will absorb as much as can be grown. The difficulty is safe transportation. Growers of pines, bananas, and oranges, should avoid being shippers.

The orange tree disease in the Bahamas has

almost ruined that branch of trade. It is to be hoped it will not extend to Jamaica.

Fancy Goods, Cameos, &c.

The West Indian Islands produce an extraordinary number of natural curiosities, which enter largely into what I might call "fancy trade." These include an incredible variety of corals, shells, marine curios, seeds, &c.; I may well add, &c., &c. The uses of these are not as well known as they should be, and many, until the late Exhibition, were rarely before seen in Europe. In countries where living is so cheap, and where at least one part of the community—the "coloured"—lives on very simple fare, I assure you these petty industries are of much importance. When the Fisheries Exhibition was at the height of its popularity, I perceived how numerous were the demands for specimens of curious products, and it struck me the market demand might easily be increased for these corals, shells, and seeds, if the inhabitants only knew how to improve themselves in manufacturing pretty ornaments, which they could readily dispose of in the piazzas of the hotels, on the decks of steamers, and on the neighbouring continent of America, in England and elsewhere, and a very considerable trade was done at the Colonial Exhibition. Among the most prominent of these marine curios are the queen and pink conch shells so greatly used at Rome, Naples, and elsewhere in Italy, for the purpose of cameo making. I believe they are mostly imported from the Bahamas, are used to an immense and increasing extent, and sell at a very low price; but I feel sure that, if a fair price were firmly maintained, as much as twenty times the price now obtained would be readily paid, as the profit, when converted into cameos and other *objets d'art*, is simply enormous. I made a fairly successful effort, with the support of Governor Blake, to establish an art school in Nassau, and sent out an Italian workman of known artistic skill and utility, to teach the coloured youths how to carve the shells, and manufacture paper knives, studs, brooches, and other ornaments out of them, with a result which was shown last season at the Exhibition, which certainly reflects much credit on the artistic instincts of the pupils. The art of carving cameos, inlaying with metals and tortoiseshell (buhl work), so as to make articles of elegant furniture; the fabrication of what are called marine jewels and mosaics; and even the manufacture, with coloured woods, of that exquisite kind of wood-mosaic called marqueterie, are arts by no means difficult to acquire, once proper instructions and models are provided. I may say, too, that the coloured population is naturally artistic. I do not mean this, of course, in the high sense of the term. Is our own peasantry so? No; but I may say that, taking into consideration the utter lack of all artistic training in the past, the average coloured man or woman will, by a kind of natural instinct, produce, under given conditions, out of shells or seeds, a far more artistic object than would an English rustic of the same status and education. The coloured people of the West Indies understand the blending of colours to perfection; it is a natural instinct with them, and, like the East Indians, they are almost invariably correct. They also possess in a marked degree the sense of what I might call pattern design; moreover, they enjoy art work, exhibiting a patience in it which not only proves the interest it affords, but also that it suits their natural inclination. What they want is technical education, and I feel certain that official attention to this would be well directed, and would repay the trouble and cost. Hitherto the people in the majority of the islands have entirely lacked teachers and proper models. This is all the more to be regretted, since there is a very great market for these articles among the numerous and steadily increasing wealthy winter residents, and in the United States. As an illustration of what can be done with these fancy trades, I will say that I have been assured that it is only thirty years since the marqueterie business was introduced into Nice from Naples, and that now it is one of the flourishing industries of that famous health resort. The seeds, beans, and corals can also be utilised in a highly lucrative manner. I dare say some who are present may remember the striking effect made in the West Indian section last year by the large cases full of seed necklaces, gorgonas, and star-fish, for the first time manufactured into pincushions and baskets, fans, and other pretty articles of *bijouterie* and *vertu*, which obtained, I am glad to say, a very profitable sale. I am sure many a poor coloured man or woman could easily pick up a comfortable living if they only knew the value of the materials lying at their service.

I see that it has been suggested in this room to establish a school for the carving of cameos at South Kensington. It is a wise

movement, and might perhaps lead to the creation of artists who might compete with those of Naples and Rome; it will in no way interfere with the establishment of like schools in the West Indies; indeed it would materially help them, by supplying them with English instead of Italian teachers, and by the enhanced demand for the raw product.

Pith Razor Strops.

Antigua and the Virgin Islands exhibited a few parcels of razor strops made of the pith of the aloe. If the strop is carefully prepared, and has a perfectly smooth and even surface, no other material gives so keen an edge. It is satisfactory to know that a firm in London is making purchases, and is confident that a demand for such articles will be created.

Kus-Kus.

The Kus-Kus grass, which is abundant in the West Indies, is barely utilised at all; whereas in India it is a well-known article of commerce, and advantageously employed in the manufacture of fans, window blinds, and screens. Being delicately scented, when damp, it produces a cool and refreshing odour. We had fine samples in the Exhibition, but none manufactured.

Dagger or Yucca Plant.

The various articles exhibited made from this plant attracted very great attention, and elicited many inquiries from dealers as well as visitors.

While the fancy manufactured articles must not be neglected, a good deal of the ribbon of a more rigid character might be sent to England. This would enable manufacturers and purchasers not only to make independent experiments with the substance, but to work it up into various articles in accordance with the prevailing taste and fashion.

It is well worth attention, but the slow growth of the plant is rather against large exports. It grows in poor land.

Palmetto Plaits.

We made many inquiries with respect to these. There is, no doubt, a market for them; if a factory could be established, and a sufficient quantity sent on to create a demand for them, very large quantities, indeed, could be sold. The Jamaica and Bahama exhibits were excellent. The sale is only a question of price.

A Winter Resort.

With reference to the West Indies as a winter resort, I may observe that within the past few years, several excellent hotels have been established, notably in Barbadoes, Jamaica, Trinidad, and Nassau, Bahamas, which latter place is much frequented by the *élite* of society from the United States, on account of the salubrity of the climate, which is so extremely beneficial in pulmonary and nerve diseases. With rapid means of communication, these islands will, I feel sure, eventually become for Americans what Cannes and Nice are for Europeans, being so much nearer New York and the other principal cities of the Great Republic.

Result of the Exhibition.

I think the Exhibition last year did a great deal of good to the West Indies. It gave the opportunity of publicly discussing the grievances and advantages of the Islands, I believe with some good results. It enabled us more fully and practically to understand where and what the West Indies really are. When one thinks of the fact, it is really extraordinary how great is the ignorance of geography often displayed by what are usually supposed to be well-educated people. This was constantly being illustrated at the Exhibition. The oddest questions were asked relative to the islands. They had an idea of the whereabouts of Jamaica, but of the rest—save, perhaps, Barbadoes and Trinidad, they were exceedingly vague. I venture to affirm that, after a visit to the Section, they went home rejoicing at least in a knowledge of the names of the various islands, and possessed with an average, even if a superficial, knowledge of their products and resources. Very amusing were the observations we overheard. Odd, for instance, to hear a distinguished M.P. ask—"What the dickens has Columbus to do with it all?" as also to hear the surprise expressed by a bishop at the ingenuity of mankind in making sheep's-wool sponge out of the wool of sheep.

The beauty of the Court has also led to much notice by the Press, resulting in a more general interest in the products. The publication of the various reports give much information of the industries of other countries, and will have the effect of stimulating many minor industries which are capable of development in the West Indies, and of introducing others, with settlers and capital. Exhibitors will understand how

to utilise to the best advantage their various goods for the markets, to preserve, cure, and pack them for exportation, and many other important results to trade must, by-and-bye, be recognised, indirect perhaps, but none the less the result of the Exhibition.*

The United West Indian Colonies suggest to the people Federation, or some equitable scheme by which they may combine not only among themselves for the protection of their common interests, but with the other portions of the empire in defence of common rights. Finally, the Exhibition has inspired H.R.H. the Prince of Wales, whose interest in and services to the Colonies can never be forgotten, to suggest, and our most gracious Queen to declare, an Imperial Jubilee Institute of the United Kingdom, the Colonies and India, to be the most pleasing to her, as a national memorial in celebration of the fiftieth year of her reign. I have very strong opinions of the good to be derived from the proposed Institution. At the present time we are no doubt exposed to influences which give cause for anxiety, in reference to commerce and industries in all parts of the empire; there is not only the danger from overproduction, but also from the great competition on the part of other nations. Our prosperity is also endangered by want of technical education for our artisans and labourers, and the merchant, manufacturer, and the planter want such a museum where the science and knowledge necessary to the success and extension of their enterprises can be obtained. I trust that the West Indian people will not fail to support the Jubilee Institute. Loyalty calls for it, and in addition, it must tend to strengthen the good feeling which is so rapidly developing in England towards the Islands. There is much inquiry at present after new products, and those of the West Indies should be kept before the public. They may not only by these means develop their commercial resources, but may also gain practical support in remedying their grievances, which undoubtedly would do much to make them realise that they are the valued, as they are beyond doubt the ever loyal, sons of a great empire.

* Since I wrote the above lines the Colonial Conference has been held. I think a great opportunity was lost by the West India Colonies by the failure to nominate delegates. They had the opportunity and should have seized it with avidity. Depend upon it, they will be forgotten unless they push forward as other Colonies are doing. I had the honour of attending at the Conference when a deputation, under Mr. Nevile Lubbock, brought the Sugar Bounty question before it. I believe that good must come from the support given by the delegates of the large Colonies.

DISCUSSION.

The CHAIRMAN said he could endorse the remarks which had been made with reference to the West Indies as a winter resort, and the excellent hotels which had lately been erected. The hotel at Nassau was built, some years ago, out of the public funds, and had been of the greatest possible benefit to the inhabitants of the Bahamas. He believed that those who sought for a quiet, happy, and contented home, might find it in any of the West Indian islands, and he trusted there was a future before these islands, though it might not depend upon the production of the single article of sugar.

Mr. HYDE CLARKE here took the chair.

Mr. MORRIS said he had spent seven years in the West Indies, having been engaged during the greater part of that time in working among the products which had been referred to by the reader of the paper. When the plan of the Exhibition was laid before the people in the West Indies, great hopes were raised, and they naturally looked forward to a great impetus being given to the numerous small industries which were now being taken up to supplement the great industry of sugar, which, owing to foreign bounties, was in a very depressed condition. The steps taken in the Colonies to send their exhibits were such, that he believed the West Indies was better represented at the last Exhibition than had ever before been the case. He much regretted that nothing had been said in the paper about British Honduras, more especially as the report issued in January last dealt with British Honduras and the West Indies. In 1883, he took an important part in collecting exhibits for the Amsterdam Exhibition; in 1884, he had charge of the exhibits sent from Jamaica for the Exhibition at New Orleans; and in 1885-6, he was chairman of the committee in Jamaica which had charge of the exhibits to be sent to the Colonial and Indian Exhibition, and was therefore in a position to be able to speak of the exhibits. It was a great disappointment to him that, in the report which had been published under the authority of Sir Augustus Adderley, there were so many errors and mistakes, rendering it not only nearly valueless, but positively misleading and mischievous through the number of errors which had crept into it.

The CHAIRMAN observed that that was not the subject before the meeting.

Mr. MORRIS thought that the subjects touched upon in the report and in the present paper were not calculated to do the West Indies any good in the future. He did not quite know what the reader of the paper meant by saying that coffee should be sent home in the parchment. Coffee was never exported in this state, and, if it were, he believed it would not find a market. With regard to kola nuts, his opinion was that there was no real commercial demand for them in this country at present. The only people who

consumed these nuts to any extent were those on the West Coast of Africa. He had heard that a kind of chocolate or cocoa had been prepared from kola nuts, but he believed this was only an experiment. He considered that if the nuts were grown in the West Indies it would be at a loss, owing to there being no market for them. The reader of the paper stated that each pod contained fifteen seeds, but if so, this must be a new variety, for he had never seen one containing more than three to six seeds, which of course are different from the "nuts" composed of the divided cotyledons. Of these there might be any number up to thirty.

Governor GOLDSWORTHY considered it would have been better if the last speaker had discussed the paper in a more friendly spirit, believing that adverse criticism would go far to prevent others from reading papers on subjects affecting the well-being of the Colonies. Having been for many years located in the West Indies, he considered the information which had been given in the paper was of great importance. No doubt they could not agree with all that had been said, but still they would not leave the room without having gained some information. He regretted to see the condition in which the West Indian colonies were, but thought the fault was due to their having put all their eggs into one basket in trusting to the cultivation of sugar. At the present moment the sugar markets were much depressed, and as they had no chance of competing with slave grown and bounty paid sugar, he hoped they would be able to hit upon some other plan for improving the position of the Colonies. With regard to British Honduras, he thought this was more an American colony than a West Indian one, and no doubt the reader of the paper had good reasons for not having touched upon its products. He had left British Honduras on leave, soon after the close of the Exhibition, and on that account the Colony had not yet publicly thanked Sir Augustus Adderley for his services. All the West Indian Colonies had expressed themselves as grateful, and he, as Governor, was glad of the opportunity of publicly doing so that night.

Mr. LASCELLES-SCOTT said with regard to the sugar industry, he had good reason for believing that a remedy, other than by fiscal arrangements, was not far distant, for Professor Robert Galloway, of Dublin, had lately devised a process whereby the enormous waste which at present occurred in the extraction of crystallised sugar from cane juice would be considerably reduced. With regard to kola nuts, he believed that when their composition was known that there would be a great demand for them. A friend of his had just received an order for twenty tons of these nuts, and a further supply had been asked for, so that it could not be said there was no market for them. The manufacture of kola paste and chocolate was continually increasing, and it had been favourably reported upon by the engineers who were laying some railway lines in the Soudan. In the catalogue of the Colonial Exhibition reference was made to the plant *Siegesbeckia Orientalis*, and this plant he found had obtained a large reputation in the Mauritius, so much so that he believed in the future it would be found to be of great value in *materia medica*. In the Mauritius the plant was known as the divine herb, and in this country it had been tried by one or two medical gentlemen, who had reported most favourably upon it. Dealing with the subject of fibres, he produced a specimen which he said belonged to the silk or cotton orders, and as the fibre had a peculiar absorbing quality, he thought it was particularly well adapted for the manufacture of surgical dressings. He strongly recommended the cultivation of this plant, believing that in the future it would find a ready market.

The CHAIRMAN said the condition of the West Indian islands was a subject which had frequently been discussed in that room; in fact, the subject of colonial products was taken up by the Society about 100 years ago. No doubt the matter had not received the attention it ought to have, and it was only in the present day that any enterprise was being shown about the subject. Formerly the Colonial-office and the Board of Trade worked together for promoting the commercial interests of the country, and it was to be regretted that this joint action had long since ceased. They had heard a great deal with regard to the diminished profit from the production of sugar in the West Indies, and it was much to be feared that no very great hopes could be entertained for this industry, even by an alteration in the bounty system. The figures given by the reader of the paper showed that the production of sugar and coffee in the West Indies formed after all but a small proportion in the importation in Europe. There were influences acting on the market which ought not to be disregarded, for instance, the great extension of local railways in all the countries fitted for sugar cultivation had caused an enormous production. From Brazil alone there was a quantity of produce thrown on the market which depressed prices, so that it was a matter of very great importance that the West Indian colonies should turn their attention to other products. The Colonial Exhibition showed the great resources of the Colonies, and what they had now to do was to turn those resources to account by a proper organisation. It was no use to have productions such as those exhibited by Mr. Lascelles Scott, unless they could be turned to actual and practical account. It was impossible for the natives of a country in any place whatever to possess scientific and chemical knowledge, but it was possible for the Government of those countries to turn their attention to the development of the resources for the benefit of the population. In the present day there seemed to be a disposition to disregard what might be called the

obligations of the community and to leave to individuals, who were in most cases incapable of doing it, the expense and labour for the necessary experiments. It was to be hoped they would become a little more enlightened in that respect, and he thought the late Exhibition had done a great deal in this direction. In the minor matters of turning to account the lower art manufactures and products, a great deal might be done. No doubt the resources of the West Indian islands were sufficient to give great prosperity to the inhabitants. He suggested that a paper should be prepared and read before the Society, showing what had been done for the creation of new resources since the sugar industry received its death blow. In conclusion, he begged to propose a hearty vote of thanks to Sir Augustus Adderley for his valuable and interesting paper.

The resolution was unanimously carried.

Sir AUGUSTUS ADDERLEY said he concurred to some extent in the opening remarks of Sir Rawson Rawson, that as the sugar industry was not prospering they should look to other products for improving the condition of the West Indian Colonies. As to the competition to develop in the future, from Queensland and India, in growing sugar cane, West Indian planters only wanted fair play; they were quite ready to fight the world, and give in if they could not make sugar as cheap. The sugar bounties should be abolished for their unfairness, and as adverse to the principles of free trade. Planters should watch the markets in order to see what was wanted, and not go on planting products which were evidently being over-produced. As to there being no market for kola nuts, he might say that he had lately sent out a large order to Trinidad, but had not been able to get the order filled. His remarks as to the parchment on coffee were based on the suggestions of M. Pasteur, and a considerable quantity was now denuded of the parchment in London. With regard to not having touched on products of British Honduras, he felt that it was impossible in a paper dealing with the West Indies to properly deal with this colony, considering that it would require a paper to itself. British Honduras merely required capital and cheap labour in order to develop its resources. As to the silk cotton referred to by Mr. Lascelles Scott, he believed it was being taken up in Germany for bedding, though he thought the fibre was not sufficiently long for the manufacture of surgical bandages. There was some similar cotton in the Exhibition which came from Jamaica, which had a very long fibre, and this, he believed, might be worked up for surgical bandages.

Sir P. CUNLIFFE-OWEN, K.C.B., K.C.M.G., wished before the meeting separated to express, on behalf of the Royal Commission, his gratitude to Sir Augustus Adderley for the noble sacrifice which he had made of his time and money in producing the magnificent West India Court at the late Exhibition. It was the wish of H.R.H. the Prince of Wales that the West Indies should have a separate Court, and that it should be placed under the superintendence of Sir Augustus Adderley. He was pleased to hear Governor Goldsworthy so promptly reply to Mr. Morris. He thought he might fairly leave Sir Augustus in the Governor's hands.

The following letter and enclosure have been received from Mr. D. Morris, assistant director, Kew-gardens, since the meeting:—

24th May, 1887.

DEAR SIR,—In the discussion which followed the reading of Sir Augustus Adderley's paper on the "West Indies at the Colonial and Indian Exhibition," the question was raised whether there is at present such a demand for kola nuts as to justify its being recommended to be grown by small growers in the West Indies. I made a statement on the subject which was contradicted by Mr. Lascelles Scott. In order to obtain an authoritative statement on the subject, Messrs. Burgoyne, Burbidge, Cyriax, and Farries—possibly the largest wholesale druggists and manufacturers of pharmaceutical preparations—were asked the present price of kola, and whether there was any demand for it. Their reply I enclose herewith.

As the object of the Society of Arts is to place an industrial and technical subject before the public in all its bearings, I hope you will be able to find room for this letter as an appendix to the discussion on Sir Augustus Adderley's paper.

I am, &c.,

D. MORRIS.

H. Trueman Wood, Esq.

[COPY.]

16, Coleman-street, London, E.C.,
May 21st, 1887.

DEAR SIR,—Replying to your esteemed favour of 18th inst., in *re* kola nuts, we beg to say that there is but little demand here for these nuts. Occasionally small parcels are disposed of at from 3d. to 4d. per lb., but if a large parcel were put on the market we doubt if they would find a ready sale, and possibly would not fetch more than 2d. per lb.

We remain, dear Sir,
Yours faithfully,

BURGOYNE, BURBIDGES, CYRIAX, and FARRIES,
per H. ARNOLD.

CORRECTION.—Page 610, col. 2, line 2. The number of bales of cotton produced at Tarsus should be 10,000, instead of 1,000.

Miscellaneous.

COTTON INDUSTRIES OF JAPAN.

The cotton plant principally cultivated in Japan is of the species known as *Gossypium Herbaceum*, resembling that of India, China, and Egypt. The plant is of short stature, seldom attaining a growth of over two feet; the flower is deciduous, with yellow petals and purple centre, and the staple is short but fine. It is very widely cultivated in Japan, and is produced in thirty-seven out of the forty-four prefectures forming the empire, but the best qualities and largest quantities are grown in the southern maritime provinces of the mainland and on the islands of Kiusiu and Shikoku. Vice-consul Longford, in his last report, says that the plant is not indigenous to Japan, the seed having been first imported from China in the year 1558. There are now many varieties of the original species, and the cultivation of the plant varies in its details in different localities. The variations are, however, mostly in dates, and the general grinding principles of the several operations are nearly the same throughout the whole country. The land best suited for cotton growing is one of a sandy soil, the admixture of earth and sand being in the proportion of two parts earth to one of sand. During the winter and spring months crops of wheat or barley are raised on it, and it is when these crops have attained their full height during the month of May that the cotton is sown. About fifty days prior to the sowing a manure is prepared consisting of chopped straw, straw ashes, green grass, rice, bran, and earth from the bottom of the stagnant pools. These ingredients are all carefully mixed together in equal proportions, and the manure thus made is allowed to stand till required for use. Ten days before the time fixed for sowing, narrow trenches, about one inch in depth, are dug in the furrows, between the rows of standing wheat or barley, and the manure is literally sprinkled along them by hand. For one night before sowing the seed is steeped in water. It is then taken out, slightly mixed with straw ashes, and sown in the trenches at intervals of a few inches. When sown, it is covered with earth to the depth of half an inch, and gently trampled down by foot. Four or five days after sowing, the buds begin to appear above the earth, and almost simultaneously the wheat or barley between which they grow is ripe for the sickle. While the latter is being harvested, the cotton may be left to itself, but not for very long. The buds appear in much larger numbers than the soil could support if they were allowed to grow; they have accordingly to be carefully thinned out, so that not more than five or six plants are left in each foot of length. The next process is the sprinkling of a manure composed of one part night-soil, and three parts water, and again, subsequent to this, there are two further manurings; one of a mixture of dried sardines, lees of oil, and lees of rice beer, which is applied about the middle of June, when the plant has attained a height of four inches; and again early in July, when the plant has grown to a height of six or seven inches, a further manuring of night-soil, mixed with a larger proportion of water than before. At this stage the head of the plant is pinched off with the fingers, in order to check the excessive growth of the stem, and direct the strength into the branches, which usually number five or six. From these branches minor ones spring, but the latter are carefully pruned off as they appear. In the middle of August the flowers begin to appear gradually; they fall soon after their appearance, leaving in their place the pod or peach (*momo*), which, after ripening, opens in October by three or four valves and exposes the cotton to view. The cotton is gathered in baskets, in which it is allowed to remain till a bright sunshiny day, when it is spread out on mats to dry and swell in the sun for two or three days. After drying, the cotton is packed in bags made of straw matting, and either sold or put aside until such time as the farmer's leisure from other agricultural operasions enables him to deal with it. The average yield of cotton in good districts in Japan is about 120 lbs. to the acre, but as cotton is only a secondary crop, this does not therefore represent the whole profit gained by the farmer from his land. The prefectures in which the production is largest are Aichi on the east coast, Osaka, Hiogo, Hiroshima and Yamaguchi on the inland sea, and Fukui and Ishikawa on the west coast. Vice-Consul Longford says that the manufacture of cotton in Japan is still in all its stages largely a domestic one. Gin, spindle, and loom are all found in the house of the farmer on whose land the cotton is grown, and not only what is required for the wants of his own family is spun and woven by the female members thereof, but a surplus is also produced for sale. Several spinning factories with imported English machinery have been established during the last twenty years, but Consul Longford says that he has only known of one similar cotton-weaving factory, and that has not been a successful experiment. Other so-called weaving factories throughout the country consist only of a collection of the ordinary hand-looms, to the number of forty or fifty, scarcely ever reaching to one hundred, in one building or shed, wherein individual manufacturers have their own special piece goods made. The first operation in the manufacture is that of ginning, which is conducted by means of a small implement called the *rokuro*, or windlass. This consists of two wooden rollers revolving in opposite directions, fixed on a frame about 12 inches high, and 6 inches in width, standing on a small platform, the dimensions of which slightly exceed that of the frame. The operator, usually a woman, kneels on one side of the frame, holding it firm by her weight, works

the roller with one hand, and with the other presses the cotton which she takes from a heap at her side, between the rollers. The cotton passes through, falling in small lumps on the other side of the frame, while the seeds fall on that nearest the woman. The utmost weight of unginned cotton that one woman working an entire day of ten hours can give is from 8 lbs. to 10 lbs., which gives, in the end, only a little over 3 lbs. weight of ginned cotton, and her daily earnings amount to less than 2d. A few saw gins have been introduced into Japan during the last fifteen years, but no effort has been made to secure their distribution throughout the country districts. After ginning, a certain proportion of the seed is reserved for the agricultural requirements of the following year, and the remainder is sent to oil factories, where it is pressed, and yields about one-eighth of its capacity in measurement in oil, the refuse after pressing being used for manure. The ginning having been finished in the country districts, the cotton is either packed in bales and sent to the dealers in the cities, or else the next process, that of carding, is at once proceeded with on the spot. This process is almost as primitive as that of the ginning. A long bamboo, sufficiently thin to be flexible, is fastened at its base to a pillar, or the corner of a small room. It slopes upwards into the centre of the room, and from its upper end a hempen cord is suspended. To this is fastened the "bow," an instrument made of oak, about five feet in length, two inches in circumference, and shaped like a ladle. A string of coarse catgut is tightly stretched from end to end of the bow, and this is beaten with a small mallet made of willow, bound at the end with a ring of iron or brass. The raw cotton, in its coarse state, is piled on the floor just underneath the string of the bow. The string is then rapidly beaten with the mallet, and as it rises and falls it catches the rough cotton, cuts it to the required degree of fineness, removes impurities from it, and flings it to the side of the operator, where it falls on a hempen net stretched over a four-cornered wooden frame. The spaces of the net are about one quarter of an inch square, and through these any particles of dust that may still have adhered to the cotton fall to the floor, leaving piled on top of the net the pure cotton wool in its finished state. This work is always performed by a man, and by assiduous toil throughout a long day, one man can card from ten to twenty pounds weight of raw cotton. Payment is made in proportion to the work done, and in the less remote country districts is at the rate of about one penny for each pound carded. As regards spinning and weaving, in the first of these branches of cotton mauufacture the Japanese have largely had recourse to the aid of foreign machinery, but it is still to a much greater extent a domestic industry, or at best carried on like weaving in the establishments of cotton traders, in which a number of workers, varying from 20 to 100 or more, each with his own spinning-wheel, are collected together. Consul Longford says the spinning-wheel used in Japan differs in no respect from that used in the country 300 years ago, or (except that bamboo forms an integral part of the materials of which it is made) from that used in England prior to the invention of the jenny. The cost of one of the wheels is about 9d., it will last for five or six years, and with it a woman of ordinary skill can spin about 1 lb. of yarn in a day of ten hours, earning thereby about 2d. There are at present in various parts of Japan, in all, 21 spinning factories worked by foreign machinery. Of four of these there is no information, but of the remainder one has 120 spindles; eleven, 2,000 spindles; two, 3,000 spindles; two, 4,000 spindles; and one, 18,000 spindles.

CULTIVATION OF RAMIE IN SPAIN.

Consul Wooldridge, of Barcelona, says that agriculturists in the Gerona district have lately been turning their attention seriously to the cultivation of the ramie plant. For some years past, in consequence of the ravages of the phylloxera and other vine pests, and of the increasing importation of cereals from America and elsewhere, the cultivation of the vine and of cereals has ceased to be as profitable as formerly in Gerona. It having been found that the climate and soil are in every way suited to the cultivation of ramie, and that the few trials that have been made have resulted in success, a factory for decortisation has lately been erected, its inauguration having been attended by the notables of Catalonia. It is said that the ramie plant is destined to replace not only the hemp and flax which is imported from France for the manufacture of textiles in Barcelona, but even that of cotton. The plant at present grown belongs to the family of the *Urticaceas*, and grows to a height of from sixty to ninety inches. It is essentially a textile plant and two cuttings may be made in one year, and cultivated under good conditions, a hectare would grow from 3,000 to 10,000 kilogrammes of stalks. At present there are few reaping machines, but as labour is cheap, the weeding and pulling of the crop is effected without much expense. The plantations at Torroella de Montgri, the district of Gerona in question have an extent of 130 hectares, but there is land disposable for the culture extending over 3,000 hectares. The price of ramie in Spain is about 8s. per 100 kilogrammes. There are three decorticating machines at work, moved by a steam-engine of 15 horse-power. Each machine decorticates 215 kilogrammes of stem in twelve hours, from which are obtained 43 kilogrammes of thread, requiring but two workmen to manage each machine—one to introduce the stalks the other to receive the fibre—and the expense is about 10s. 5d. per 150 kilogrammes of thread per day.

CAPE DRUGS.

Very little, indeed, is known of the medicinal agents employed by the natives of South Africa. The bulb of the *jeukbol* (*Drimia ciliaris*), much resembling the officinal squill, is used as an emetic, expectorant, and diuretic; its juice is highly irritating in contact with the skin, hence the local name, meaning "itch-bulb." A curious animal product, termed *hyraceum* by pharmacists, is said to be employed with the same effect as *castoreum*.

The prominent native narcotic is tobacco, which is extensively planted. The manner of preparing it, however, must in a great measure destroy its flavour; it is mashed together in a hollow piece of wood, by means of a heavy pole, into little round balls of the size of an orange, which, when dry, are broken into smaller pieces. The leaves of a composite plant, *Parchonanthus camphoratus*, when dried, are smoked by the Hottentots and Bushmen instead of tobacco, exhibiting slight narcotic effects; in the form of infusion they promote perspiration, and are said to be useful in spasmodic asthma. The beautiful-flowered labiate plant, *Leonotus leonurus*, is abundant at the Cape, and is also smoked by the Hottentots instead of tobacco, with similar narcotic symptoms to the preceding. Near Delagoa Bay the natives have a curious custom of drawing snuff up their nostrils through a long, hollow bone from a bird's wing.

The stem of a shrub, *Derris uliginosa*, is beaten and placed in still waters as a fish poison in Zambesiland. The fruit of *Randia kraussii* is similarly employed.

Obituary.

Henry Liggins.—Mr. Liggins died at his house in Ladbroke-square, on the 12th inst., in the 70th year of his age. He was the owner of large property in the Island of Antigua, and was warmly interested in all matters connected with the West Indies. He was also a shipowner, and took a great interest in nautical affairs. He was a constant attendant at the annual meetings of the Institute of Naval Architects. In 1875 he was elected a member of the Society of Arts, and he was present at most of the meetings of the Society, frequently taking part in the discussions. His presence at the meetings will be greatly missed.

General Notes.

Aniline Dyes.—A noticeable feature in the Indian trade returns is the large increase in the employment of aniline dyes in India, in the place of the indigenous colours formerly employed for their woollen yarns, silk, and cotton. The value of the imports now averages £100,000 a year. The imports of aniline dyes were to the value of £77,159 in 1883, £110,324 in 1884, £104,395 in 1885, and £61,619 in the first eight months of 1886.

MEETINGS FOR THE ENSUING WEEK.

Tuesday, May 31...Royal Institution, Albemarle-street, W., 5 p.m. Professor Victor Horsley, "The Modern Physiology of the Brain, and its Relation to the Mind." (Lecture III.)

Wednesday, June 1...Anglo-Jewish Historical Exhibitions, Royal Albert-hall, Kensington-gore, S.W., 8½ p.m. Rev. A. Lowy, "Hebrew Literature in England."

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 53, Berners-street, W., 8 p.m.

Thursday, June 2.. Linnean, Burlington-house, W., 3 p.m. 1. Rev. G. Henslow, "Transpiration and Living Protoplasm." 2. Mr. S. Moore, "Light and Protoplasmic Movement." 3. Mr. C. Potter, "Algæ on Tortoise." 4 Mr. D. Scott, "Nuclei in *Oscillaria*."

Chemical, Burlington-house, W., 8 p.m. Ballot for the Election of Fellows.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture VII.)

Archæological Institution, 16, Burlington-street, W., 4 p.m.

Friday, June 3...United Service Inst., Whitehall-yard, 3 p.m. Discussion on the subject of the Military Prize Essay, "Lessons to be Learned from the Campaigns in which the British Forces have been Employed since 1865."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. D. Gill, "The Application of Photography to Astronomy."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Paper by Professor Napier.

Saturday, June 4...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. W. Hales, "Victorian Literature." (Lecture IV.)

Actuaries, The Quadrangle, King's College, W.C., 3 p.m. Annual Meeting.

Journal of the Society of Arts.

No. 1,802. Vol. XXXV.

FRIDAY, JUNE 3, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 15th June.

Each member has had sent to him a card for himself, which is not transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each. Not more than four tickets will be sold to any one member, and not more than 2,000 in all. When 2,000 have been disposed of, the issue will be stopped.

Tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter, a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, &c.) will be supplied. No refreshments can be obtained by purchase.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

Further particulars as to the arrangements will be announced in future numbers of the *Journal*.

INDIAN SECTION.

Friday, May 27, 1887; Sir Roper Lethbridge, C.I.E., M.P., in the chair.

The paper read was on "The Indian Tea Industry; its Rise, Progress during Fifty Years, and Prospects considered from a Commercial point of view." By J. Berry White.

The report of the meeting will be printed in next week's number of the *Journal*.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 24, 1887; Prof. Hubert Herkomer, A.R.A., in the chair.

The Chairman, in introducing Mr. Crane, remarked that every one, both old and young, owed him a debt of gratitude for his children's books, and he (the Chairman), in common with many others, regretted that they had ceased to appear at Christmas. In that work, Mr. Crane struck out with a strong arm against the very paltry type of book illustration which was then prevalent—a type upon which all children up to that time had to grow up. Those who knew how fatal it was for children to grow up on bad works of art, and how different it was with those who had grown up on Mr. Crane's books, might well hope to see some great results from this apparently small work. He congratulated Mr. Crane on having the power of striking this blow against bad art, and felt sure that the paper he was about to read would be pregnant with the right kind of thoughts.

The paper read was—

THE IMPORTANCE OF THE APPLIED ARTS, AND THEIR RELATION TO COMMON LIFE.

By Walter Crane.

Man, in a natural and primitive condition does not begin to think of ornamental art until his physical wants are satisfied, since art is, in its true sense, after all, only a spontaneous manifestation of mental life in form, colour, or line; the outcome of surplus human energy. It is only under what is called modern civilisation that this natural order is artificially reversed, and men are forced, to attempt at least to produce forms of art in order to satisfy their physical

wants. Our troubles and failures in art may mostly be traced, directly or indirectly, to this condition of things; all the horrors and abominations perpetrated in the name of art, from the productions of the poor man whom necessity compels to chalk on the pavement, through the countless varieties and inanities of the fashionable store, to the refined cruelty of what is known as the "pot boiler" in the "Fine Art" Exhibition.

The primitive hunter in his cave, when his earliest efforts in applied art, in the form of flint weapons, had secured to him a sufficiency of fish and game, and furred overcoats, began to record his impressions of the chase, and to scratch the forms of his favourite animals on their bones. If these representations of reindeer, mammoth, and bison, be indeed the earliest examples of design, it would seem that its first impulse is imitative rather than what I should term expressive and decorative; the spirit of the picturesque sketcher recording his impressions of natural forms, rather than the ordered, systematic, applied art of the inventive designer, who uses natural forms or colours, much as a musician his notes, to produce a rythmical arrangement—a tune, a pattern; and such a pattern may be made to express not only the beauty of the material in which it is wrought, but also the utmost play of fancy and imaginative resource. If this inference is correct, we may perhaps take comfort in the thought, that out of our present pictorial zeal and cultivation of the picturesque sketcher, we may be led to the study of a more abstract, ideal, and intellectual side of art.

However the conscious invention of line and its variation in pattern came about, whether by the burnt stick of the idler (according to Mr. Whistler), or on the soft clay of the primitive potter, it is tolerably obvious that certain primitive patterns are derived from certain necessities of construction, such as the chequer from the square plait of a rush matting, when they are not taken straight from Nature's pattern-book, as in fish or serpent scale, and fan from leaf or shell. One of the most natural impulses in man is to make a mark or a cut upon something directly he has time on his hands. We can watch the development of this impulse in children. One line or mark suggests another, and strokes following one another in a certain order are found to have a pleasant and interesting effect. Strings of them, round clay vessels, were found to make them more exciting to the eye than the plain surface. The handles of dirks and hunting knives, and horns, bows, hatchets, nay, even man's own skin, all offered opportunities for the early ornamental impulse in carving and painting patterns. The implements in constant use, on which, indeed, rude as they were, life itself depended; the things most familiar, most valuable, constantly before the eyes or in the hands—these were the first things to receive the touch of art, which was then "applied" indeed, and applied only.

If we follow the manifestations of the artistic sense through the great historic periods, say from Homer to Shakespeare, we shall always find life and art, beauty and use, hand in hand; the utmost artistic skill of invention and craftsmanship lavished upon cups and bowls, upon lamps and pitchers, upon dress and jewellery, upon arms and armour. We shall find the highest imagination, the most graceful fancy, and even wit, humour, and satire, in the service of architecture, recording and reflecting the sentiment of the people; built into cathedral aisles and vaults, or glowing from the windows, frescoed upon the walls, or gleaming in the splendour of mosaic, or carved in endless fertility of resource on the stalls and misereres.

Under economic conditions of the production of all things for the service or delight of man, for use instead of, as now, for profit, the craftsman was an artist, and all objects under his hand naturally developed a characteristic beauty. Ornament was organic, completely adapted to its material, and expressive of its object; but with all our industrial organisation, sub-division of labour, and machine production, we have destroyed the art of the people the art of common things and common life—and are even now awakening to the fact.

Under a commercial system of production and exchange, all art has been rigidly divided into classes, like the society it reflects. Since we have to sell it across the counter, as it were, we must take the weights and scales to it; we must apply to an article of commerce the tests and standards of commerce. Thus, we have divided beauty and use, and made them up in separate parcels; or, perhaps, having reduced both to powder, we try a conscious blend of the two to suit average tastes. We have the arts all ticketted and pigeon-holed on the shelves behind us. We have "industrial," "decorative," or "applied" art, as we now call it, and "fine" art. Fine art and "the arts not fine," as my friend Mr. Lewis Day has it. Thus, by degrees, the vast general public, who must get their ideas of art, like

other things, ready made, have been taught to understand by the word "art" chiefly that form of portable, and often speculative, property—cabinet pictures in oil. Nor is this altogether wonderful, considering how, under our system of wholesale machine production, the appliances of common life have lost their individuality, interest, and meaning, together with their beauty. We are not sensible of any particular individual effort of thought or invention in an object which is only one of thousands turned out exactly like it. Plates, cups and bowls, chairs and tables, ; the moulding and panelling of our wood-work, and the metalwork of our sacred hearth itself, are taken as matters of course, like other productions of commerce. They were not specially made for you and me ; they must be made to suit Smith and Jones equally well, or equally ill; and we shall probably be charmed to see them in each other's houses. We know that furniture and fittings are only made to sell at a profit while the fashion lasts. Trade demands its "novelties" every season, and it would never pay to let a man sit contentedly in the chair that was solidly built for his grandfather. Much better let him fall between two stools in his uncertainty as to in which of the confidently named upholsterers' styles to seat himself.

Then, as to the application of art to the walls of his dwelling itself, is the average man in a much better case? You cannot expect him to put up costly and permanent decorations for the benefit of his landlord, either outside or inside. He is a wandering hermit-crab, only too glad to find an empty shell that will reasonably fit him, at a not too exorbitant rent—and as for decoration—well, at least there are paint and paper hangings.

Of course they that are rich can hire a great architect, and dwell in a perfect grammar of ornament. They can import the linings of Italian temples and tombs, and the spoils of eastern mosques, to breakfast, dine, or play billiards in. The only fear is that Tottenham-court-road will soon bethink itself of cheap imitations of such antique wreckage; that Westbourne-park and Camden-town may be even with Mayfair and South Kensington! Cannot the moderate citizen already command his household gods in any style at the shortest notice? Great is commercial enterprise! Nothing is too high or too low for it. Where your fancy is there will the man of profits be also.

The distinct awakening of interest and practice in the applied arts, which is a mark of our time, I should be the last to belittle or attempt to ignore; but at the same time, with all it has done and is doing for our education, with all the remarkable skill, and reproductive antiquarian energy it has called forth, I feel that we are landed in a strange predicament. For while, on the one hand, new sensibility to beauty in common things and new desire for them is awakened, on the other, they are in danger of being choked by that very facility of industrial production which floods the market with counterfeit—set in motion by all the machinery of that commercial enterprise which is the boast of the age, but which all the time, by the very necessity of its progress, is fast obliterating the remains of ancient art and beauty from the face of the earth. So that it will be written of us, that we were a people who gathered with one hand while we scattered with the other.

Economic conditions prevent our artisans from being artists. They have become practically, and speaking generally, slaves of machines. The designer is another being from the craftsman. It is only by a study of the conditions of the material in which the design is to be carried out, that we can get even workable designs; and even at the best, the designer who has no practical acquaintance with any of the handicrafts, necessarily loses that stimulus to invention, that suggestive adaptability which the actual manipulation of the material, and first-hand acquaintance with its own peculiar limitations and advantages, always gives.

One who developes a faculty for design has rarely a chance of being other than a designer. He has no time to make experiments—to strike out new paths; he must stick to the line by which he has become known, in order to get a living. Nothing narrows a man so much as working continually in the same groove. The utmost that can be said for specialising a single capacity is that you get an extraordinary mechanical or technical facility at the cost of all other qualities. It may not be possible to be supreme in more than one art, but the arts illustrate each other, and a knowledge of other arts, and their capacities and limitations, is sure to re-act upon an artist's practice in the one which most absorbs him. It is true we hear of artists here and there, who, though in the eye of the world inseparably associated with some particular form of, say, pictorial ability, nevertheless cultivate some secret amour in the form of a handicraft.

Professor Herkomer invited us [the other

day to see his wonderful application of the arts—his demonstration of their practical unity on his own premises at Bushey; and a most striking, interesting, and instructive exhibition it was. Perhaps few who know him only by his pictures would suspect him of being an accomplished artist or craftsman in many other arts, notably in wrought iron. From the personal point of view, he offers a solution of how to associate art with everyday life. He is devoting his energy and artistic skill and invention to making domestic art, including architecture, monumental. The works at Bushey, if Professor Herkomer will allow me to say so, exemplify not only the power of individual direction and organisation, but also the power of co-operation and unity of aim in the arts founded upon, solidified, and supported by, family traditions of skill, invention, and workmanship in the crafts, and how effectively all may be united in a common purpose. Another noteworthy fact was the remarkable way in which scientific and mechanical invention can be made to serve artistic purposes, as in Professor Herkomer's application of the dental point to the carving and chasing of metal, and in the drilling machines we saw preparing work for the wood carver. In so far as such a use of machinery does not necessarily condemn any man to be the slave of it—to be a machine-minder all his life—it would seem to be the natural and reasonable use of machinery in the preparation of work, to save the drudgery and waste of energy in its preparatory stages, and so reserve the delicate hand work until the stage at which it becomes really effective.

One question here occurs to me I have often wished to ask Professor Herkomer, and perhaps he will let me take the present opportunity of doing so. In a lecture given at Toynbee-hall a while ago, he is reported to have said (I know not whether correctly or no), in speaking of the early struggles of his family in America, that at one time it was part of their work to carve wooden brackets for houses, and figure-heads for ships, and other "degrading" work. It was this phase "degrading" that troubled me, since to my mind no honest work is degrading, only the excess of it, or the conditions under which it is done. As to figure-heads, rudely carved, quaint, and grotesque as they sometimes were, with their accompanying scroll-work, they are, I fear, with the last relics of applied art, disappearing from our ships, and I, for one, certainly deplore it, and feel that the black iron sides of our smart and swift "clippers" and "liners" look somewhat bald and devoid of suggestion and romance, compared with the old wooden walls and their interesting carving and ships' carpentry.

There was another thing that struck me about Professor Herkomer's work, and that was the feeling and poetic sentiment he had enshrined in some of his beautiful carved cabinets. We all know the sentiment and charm of association which naturally gathers in time about some piece of domestic furniture. Now art applied to furniture has the same, or rather a higher, power than time, for it can, by beauty of design and workmanship, invest a seat, or a cabinet, or a fire-place with a poetry of its own, far more subtle, penetrating, and suggestive than perhaps any form of art, because indissolubly associated with daily life and its drama.

But when we hand over the production of these things to the trader, how can we expect any sentiment or poetic thought to collect about them? Try an arm-chair, for instance, that will not bear the weight of time, and has never received the touch of art?

I dare say furniture may be found to serve our turn—good enough for our shifting life of hurry, and strong enough to last out its own fashion. I can only say that, if we care for genuine art in these things, we must not expect to get them under the ordinary conditions of trade.

Yet there is not a thing we use, not the commonest appliance in our houses, that does not show some effort, at least, to have been spent upon it, to make itself presentable to humanity. Unfortunately, now-a-days, when native instinct has been so much swamped by forced mechanical industrial production, and the search for mere mechanical smoothness and superficial polish, instead of the finish which only comes of thought and loving care, these efforts to be ornamental are too consciously afterthoughts, while the eye is on the market and its blind chances and uninspiring averages. The added ornament to a thing of utility, instead of being a manifestation of the craftsman's feeling who made it, and his sense of pleasure in his work, is too often some miserable shred torn from the reminiscences of some dead language of decoration—all its grace and spirit gone; and even if moderately adapted in type and form to its purpose, is not calculated to bring a light to any eye, or joy to any heart, since it is but the product of joyless toil and competitive production—the mechanical smirk on the face of the thing of

commerce that it is, intended to beguile the simple-minded and unwary into the momentary belief that it is a desirable and beautiful thing, when, in another sense than the poet's, it—

"Stands ready to smite once, and smites no more."

The unhappy cheapening and vulgarising of ornament, so far from fostering a taste for art, only degrades and distorts the natural feeling for beauty which, with reasonable scope and pleasant surroundings, would develop itself, as it has always done. Let not commerce pride itself in cant phrase on its claim that it places "art within the reach of all," for how could that have become necessary until art had first been put out of reach? What could compensate for whole tracts of country desolated, and for the crowding of the people in our cities under conditions which put ideas of human dignity and beauty practically out of the question for the million?

Among the secondary reasons for the decay of inventive and spontaneous design in the applied arts, I believe the hard and fast line which has been drawn between the artist and the craftsman is answerable, and the separation of the designer and the workman. The designer is, perhaps, kept chained to some enterprising firm. Novelties are demanded of him—something entirely new and original—every season, but not too much so. It is not surprising that the best talents should get jaded under such influences; that fancy should become forced or fantastic, and motive weak and tame, or perhaps lost altogether in a search after superficial naturalism, in defiance of fitness to material or use. Such a Nemesis is too apt to overtake the specialised designer, who designs on paper only, without the stimulus of close acquaintance with, and practice in, some handicraft. The mere change of occupation is refreshing and invigorating, and stimulate the inventions.

In so far as I have been successful as a designer, it has been, I believe, largely owing to my making myself acquainted with the conditions of the material in which a design was to be carried out; by striving to realise, in thought at least, the particular limitations and conditions under which it was intended to be worked; and I have always found that those very limitations, those very conditions, are sources of strength and suggestion to the invention. For I am old-fashioned enough to believe that every material has its own proper language—regarded as a medium for expression in design—and it is the business of the designer to find this out.

The naturalistic or imitative impulse in art which is characteristic of our time, with the enormous and surprising development of the photograph, have had very visible effects upon art of all kinds. It is quite distinct from the expressive or inventive impulse, and though there may be a ground of reconciliation, the former is of far less consequence to art in its applied or related form than the latter.

What may be called the dominant art always seems to impress its own peculiar characteristics upon every other. Whereas, in former periods—Ancient, Classical, Mediæval, Renaissance—architecture may be said to have ruled over all the arts, which in their earlier history were really essential parts of it; and even when, by degrees, the family parted company, and went out individually to seek their fortunes more or less independently of each other, evidences of their architectural descent still clung to them; as in the architectural construction and character of portable furniture and fittings, and of their ornamental details. Sculpture and painting to this day are obliged to retain the rudiment which betrays their architectural parentage, in the one case, by the plinth which supports the bust or the statue, and in the other, by the moulding of the frame, with which the least architectural or decorative picture cannot dispense.

But pictorial art has now usurped the first place in the popular mind. It has influenced architecture, directly, in so far as it has led to the erection of a new type of building—the picture gallery—a place built with the sole aim of displaying pictures not painted originally with any idea of concert, or to be seen side by side. Surely, a remarkably inartistic way of regarding art! Indirectly, the effect of pictorial art, and pictorial ways of looking at things, is seen in what has been called the "architecture of the sketch-book;" the somewhat restless and fantastic designs in a mixed style, chiefly in domestic work, full of little bits, nooks and corners, which is characteristic of the last decade; for all that, a pleasant change and relief from the dull monotony of the quasi-classic style which preceded it. Sculpture, too, has not escaped the pictorial influence, as is shown, for instance, in the naturalistic school of modern Italy, which closely imitates in marble, textures, surfaces, and momentary grimaces as closely as possible, but with more skill than taste. Abundant

examples of such misapplied imitative skill are still to be found in other arts, such as wood-carving, pottery painting, metal work, and textiles; although it is only fair to say that, of late years, in these arts there has been a distinct return to sounder principles of design, with the revival of a feeling for the capacity of the material which embodies it, and a recognition, over and above mere reproduction of old work, of the distinction between art and nature which is so often lost sight of. For all that we are never sure, amid the vagaries of fashion, that we shall not suffer a relapse—that we are not threatened with an irruption of tea-roses, in high relief, on our curtains and chintzes, and landscapes (not carboniferous) on our coal-boxes.

On the whole, however, the applied arts have shown a laudable independence and defiance of the pictorial mood. The dog no longer appears (after Landseer) on the hearth-rug, but is often, in metal, relegated to his proper place on the hearth itself. So far so good. Albeit the desire for some of the happy results in art, which belong to ages of greater simplicity of life, has produced in some cases strange results, and some combinations of ancient kitchen and modern drawing-room one has seen are not altogether happy, we get an impression of the affectation of primitive simplicity and homeliness, with modern luxury and artificiality, from which, at any rate, we can draw a moral on the connection between art and life.

The movement initiated by Mr. William Morris, and the gifted artists associated with him, to which we owe so much, began in a genuine return to honesty of purpose, and to sincere design and sound workmanship, grounded upon a study of good models in the past; but it was the outward and visible sign of an intellectual movement which has its eyes upon the future, and, like all revivifying and stimulating impulses in art, it is the offspring of hope and enthusiasm.

Let us look to it that this English renascence of ours is not extinguished—that it does not fall utterly into the iron grasp of commercialism. But, indeed, we may figure art as the fair Andromeda chained to the rock of modern economic conditions, in danger from the all-devouring, desolating monster of gain, until the deliverer shall come.

This is, in sober truth, the situation. Under our system of centralised industrial production, local art and industry are everywhere being dispossessed, and local characteristics and varieties are being fast obliterated. The machinery of trade forces prevailing patterns everywhere, and the mass of the world cannot pick and choose, or turn the stream of invention for their particular delight. It must accept the latest novelty of commerce, and content itself for all shortcomings with her assurance that it is "just out," and will certainly be "the fashion." Thus it comes about that our cups and bowls, our tables and carpets, rather speak of the enterprise of a firm than the historic traditions of a people, or the skill of a race of artists and craftsmen. The zeal to make things "pay" has eaten us up, in the artistic sense. It is all very well to talk of improving with art the common accessories of life, to cultivate the handicrafts with enthusiasm, to distinguish ourselves by beauty of design and technical excellence among the nations of the earth, and, after all, for a man to find that in proportion to the extra care, delicacy, and invention, in proportion as the craftsman works in the spirit of the artist, and is true to himself, without regard to trouble or time, the more difficult will he find it to make his living.

While such enormous differences in reward and chance of appreciation exist as they do at present in art, it is not encouraging to the artist in wood, stone, or metal to find that, however sincerely he may work, he must work in comparative obscurity, at a very modest scale of remuneration. As long as the chance of individual distinction and substantial reward are so conspicuously in favour of the pictorial artist, in spite of the best schools of design, and all the machinery for diverting the stream of artistic feeling, skill, and invention into their proper channels, I am afraid the tendency will be for every student who fancies he develops artistic ability to press into the already overcrowded ranks of picture painters.

The Society of Arts, under this Section of Applied Art, are offering prizes for skill and invention, in various handicrafts, to art workmen. This is a step towards giving at least a chance of recognition in this direction. Many schools and institutions are in existence for the special training of workers in the crafts, such as the Home Arts and Industries Association, the Institute of British Wood-Carvers, the School of Needlework, and the School of Wood-Carving at South Kensington (of which Miss Rowe is the manager), and I believe good technical training may be

obtained at the City and Guilds of London Institute.

There is, indeed, on all sides unmistakeable signs of great activity, great interest, manifested in the various handicrafts. There is in some directions, indeed, some danger of that dilettanteism which is too apt to affect movements which do not begin at the root. It is of no use touching any form of design except in a serious spirit, and we should not be happy in the thought of a revival of the crafts merely to fill the elegant leisure of amateurs. It is too often forgotten that, after all, it is no use cultivating an art—a language, a means of expression—unless one has something to say in it, and that all the beautiful arts which fall under our heading of "Applied" depend finally for their vigour and interest on power of design. The worker in any branch of art is under the pressing responsibilty of making his work good of its kind, or the world is not better for it.

When we hear, however, of the magnificent sum of five shillings being offered as a price for carved panels in a cabinet, it is not stimulating to those who look to winning a competency in the practice of so highly-skilled and artistic a craft as wood-carving. We may lay such facts at the door of competition, or apathetic indifference to applied art, as it pleases us; but I venture to think that if the crafts and arts were recognised in public exhibitions of art, which are now practically devoted to one form of painting, it would do something. It would at least offer a chance for individual distinction in some other form of art. The work of the designer and craftsman could be seen, and by degrees people would begin to realise that beauty of design and workmanship counted for something besides in painting alone, that the main business of an artist was not to emulate the photograph, or to take the wind (or the effect) out of the canvas of his neighbour in the pictorial struggle for existence (through unnatural selection) known as a fine art exhibition.

In those periods of the past which we regard as great epochs in art, the arts and crafts are in harmony and close relationship with each other. The culminating glory and mastery of Renaissance painting, could hardly have existed without being founded upon the firm basis of the handicrafts, set as it were like a gem in a not less beautiful framework of invention in all branches of design; and we know that more than one great Florentine painter came out of a goldsmith's workshop. Such pictures as those of "The Adoration of the Magi," by Mabuse (shown at Burlington-house a winter or two ago), or Crivelli's "Annunciation," in our National Gallery, seem to sum up the contemporary beauty of the handicrafts, and give them back to us again. A beautiful book was lately brought out on Italian ornament, from the patterns on dresses and hangings in pictures in the National Gallery; and taking the 15th century painters generally, we might get a perfect cyclopædia of applied design from the beautiful details which enrich their pictures. It was not archæology then, but the love of beauty and richness, the delight in the splendour of life, which led them to paint such things, and also, probably, because they were craftsmen themselves as well as painters.

I believe we are making a mistake in training students in art, from first to last, solely with the pictorial view. The imitative powers are cultivated to the utmost, while the invention is neglected. The superficial effects of nature are studied, while the expressiveness and value of pure line, and its bearing on applied art, is very much overlooked. Thus the designing constructive power, seems to be considered secondary to the depicting power—or rather one phase of it. The consequence is, we get large numbers of clever painters, and graphic sketchers, but very few designers. Everything is looked at from the pictorial point of view, and the term artist has been narrowed to mean the pictorial or imitative painter.

I should like to see a reversal of the principle. I should like to see a course of training in the handicrafts come first, as the most important to the cultivation of a sense of beauty in common life—not to speak of its importance to an industrial country, in an industrial age.

The arts are really inseparably associated and interdependent; none is greater or less than another, and all are in some sense applied. We are all, consciously or unconsciously, affected by our surroundings; we may become sensitive to beautiful shapes and colours or lines, and afflicted by those ugly and coarse, or grow callous and insensible to them, which is perhaps the commonest result. It is, therefore, hardly possible to attach too much importance to art in its applied forms, seeing its intimate association with, and bearing on, life itself, through all sources of refined pleasure.

DISCUSSION.

Mr. LEWIS DAY said he practically sympathised with all Mr. Crane had said, and he was glad to hear him say something in favour of machines. All artists knew that machines could not do their work, but it was a fashion to speak of a machine as a fiend incarnate, which he thought a mistake. Like it or not, machinery was there, and the best way was to make a good use of it. The Chairman himself had illustrated the right use of machinery in metal carving. It was suggested in the paper that the designer and workman ought to be one, but he thought that theory might be carried too far. Of course, they should work together. Men could not always be turning out new things, and it was just as well to be employed sometimes more or less mechanically. People are not all alike; some men had the impatience which belonged to the designer, while others had the plodding skill which belonged to the executant. It was a mistake to say, "this poor man is compelled to spend his whole life in executing work laboriously," for he had come across workmen who were happiest in producing the same thing over and over again, and were bothered when they were told to invent something. Inventing was delightful, but there was not so much invention as one might think. With regard to the patterns referred to in the 15th century paintings, it would be found there was seldom any novelty, although there was great variety. They were all built on the same plan, and that was one of the secrets of the early workmen's success. Now-a-days, the manufacturer was always worrying for something new. The characteristic of decorative art was a certain reticence, for in many cases it only served for a background, and in order to make work fit that necessity, the artist should seek for qualities quite different to those demanded by the manufacturer. As he had heard an American express it, he wanted a pattern with "snap" in it; but that was just the thing which was an abomination in decorative art.

Mr. E. C. ROBINS said that, while listening to the paper, he could not help thinking of the lines—

"A cunning artist may in cloister sit,
And carve and paint a thousand things,
And use both art and wit.
Yet wanting world's renown may pass unsought or seen,
It is but fame that outruns all, and wins the goal, I ween."

That seemed to be the moral of the paper. One of the aims of the Applied Arts Section was to bring public attention generally to the fact, which had been found in all stages of civilisation, that it would be much to the advantage of art if we knew the man who invented the things which we all saw and enjoyed. With that object prizes were offered not to the firm who sold the things, but to the man who made them. The committee owed very much to Mr. Crane for the counsel he had given it, how to make art felt as a pleasure and a profit in every station of life. When this was done, the workers would deal with the subject under their hands in quite a different spirit, and produce very different results. Enthusiasm was wanted in everything. Enthusiasm for humanity produced the philanthropist, and enthusiasm in art produced the artist. But no enthusiasm could grow when every art was kept down by the sense of want; the necessity of getting a livelihood crushed out from the man all that enthusiasm which was necessary for the development of his highest capacity.

Mr. HAITE thought all who knew anything of the subject would agree with the opinions expressed in the paper. It was gratifying to see that the subject of the decorative arts was at length being recognised. The Chairman had shown very clearly how possible it was to combine pictorial and decorative art, though he (Mr. Haité) well recollected the time when design was denied any place in art at all. He saw many around him who could corroborate this statement, and he was very glad to find the Society of Arts had determined to recognise art on the part of the craftsman. They had had many promises of the kind before, but now at length there seemed some chance of these being realised. The creation of machinery was for a time the death blow to the decorative arts, but they had now began to revive. The mistake was in attempting to make machinery do everything, but it might aid greatly in doing mechanical work, and saving unnecessary labour, leaving more energy to be expended on the really artistic portion of the work.

Mr. CURRAN, on behalf of many wood-carvers present, wished to thank Mr. Crane for his paper. He seemed thoroughly to understand the difficulties they had to contend with, especially in his remarks on the separation between the designer and the art workman. He thought Mr. Crane must have had some experience of the life of the wood-carver, who had to go into work at the ringing of the bell in the morning, and keep his nose to the grindstone until the bell rang again in the evening, with a short intermission, utterly irrespective of whether he felt inclined for it or not. He did not suppose wood-carvers were worse off than others, but this was at the bottom of a good deal of the bad art workmanship. Another thing was that the workman must not have an idea of his own, or, if he had, he must not express it, or he would soon be sent about his business. With regard to the carving of figure-heads, &c., for ships, he might say that he had known men who had served their time at such work on the Clyde, and on coming to London they turned out some of the best carvers he had known. Although they were accustomed to this bold class of work, they were able to carry it down to small details, and to do any work required of them. The workman was not allowed to exercise his faculties or his ideas; he was made a mere machine. It had often struck him, in looking at old

work in which there was no particular artistic merit from the point of view of treatment, but in which some simple scene was reproduced, such as hounds after a stag, how much better it was than a monotonous ornament all round a room, having no idea in it, though the workmanship might be perfect. If the carver were left to his own design sometimes, he would put more idea into it; but if this system were suddenly introduced, it would take some time to throw off the trammels of generations of mechanical work; they could not become artists all at once. But if employers were to exercise a little more personal supervision, and not trust so much to machinery, and give the men a chance, and if they showed any art faculty, encourage them to pursue it, it would be a step in the right direction, and by degrees there would grow up a set of designers who were also art workmen.

Mr. Hunter Donaldson said he had been an employer for many years of art workmen, particularly wood-carvers, and he knew something of their work. He must say that, in his own firm, and in others he was acquainted with, there was no disinclination to recognise and encourage any ability a workman might show. In London, and in Florence—the latter being the head of the modern carving school—the same system was adopted. The designers of the establishment produced the designs, and the workmen carried them out. But if the workman was a good one, the employer looked to him to give such an interpretation to the design as should have a specific individuality, and make it not merely the mechanical thing which had been referred to, but something which had in it some of the idiosyncrasy of the individual. No matter how rigid the original design might be, there was always some latitude allowed to the carver, and he was always delighted to recognise good work amongst carvers, some of whom he had known more than twenty-five years, and give them every encouragement in his power. Those who had had the privilege of visiting Professor Herkomer at Bushey would see how very advantageous a thing machinery was. Some decried it; but to meet the requirements of modern life, and to produce work under given conditions, it was of the very highest value; it only required the right application. If every one had unlimited time and money they might afford to disregard machinery, and could produce work as they did in the Middle Ages; but modern conditions required a more rapid mode of production, and as all persons of moderate means desired to have something well executed in their houses, resort was naturally had to machinery. Delicately wrought mouldings of exquisite finish could be produced by machinery, more perfect indeed than they ever could by hand, and in fact some could not be produced by hand at all unless at enormous cost. With respect to workmen becoming artists, the schools of design had done something to enable a workman to become a designer, but possibly they might have done more in that direction if they had been exclusively devoted to the development of the faculty of design amongst workmen and others, instead of dealing with other phases of art. But those who knew the years of training demanded to achieve anything like excellence in higher class cabinet work, or skill in carving, would feel that for an ordinary workman, surrounded by all the difficulties of his position, to become an artist as well as a workman, was practically almost impossible, certainly under the conditions of modern trade. Some common sense must be brought to bear, and though they would all like to be Cellinis, and possessed of manipulative as well as artistic power, practically it was not possible. They must, therefore, recognise the necessity of having highly skilled workmen capable of interpreting artistic designs. A few days ago he was invited to see a collection of so-called "works of art" at the West-end. They occupied three large rooms, and consisted of wood-carving, a little cabinet work, fans, screens, over-doors, panels, and the numerous things employed in the decoration of a modern drawing-room. They were shown by a lady very intelligent and charming, but unfortunately she had had no training in art, and she had brought together there a number of literal horrors and abominations. Yet the rooms were nearly filled with people, most of whom came in their carriages, and they went about exhausting the vocabulary of laudation in the most extraordinary manner. The inference he drew was that many people who ought to acquaint themselves with art matters were grossly ignorant of it. Since then he had seen a collection of 16th century French furniture; of course it was ridiculously expensive, and produced under totally different conditions to those under which modern furniture was made, but still it was a delight and a charm to the past, present, and all succeeding ages. It was only right to say, however, that he knew one firm in London producing furniture, notably a pianoforte which he had seen, which seemed to him the very highest expression of modern work and artistic design. Without love of art, money, and time, excellence could never be achieved. They might all congratulate themselves that dogs had disappeared from hearthrugs, and other enormities were disappearing as a consciousness of what was right grew up in the public mind.

Mr. Alexander Payne remarked that the most valuable feature of the paper was that it pointed attention to the fact that the workman himself should be sought out. They did not want to go to a firm of traders who employed good workmen, but to get at the man who did the work with his own hands. He spoke as an architect, and he knew that if he wanted to get good ironwork there was only one way to get it—to find out the man himself who was a good worker, to show him the design, and ask him to point out any alteration he wished made in it, and having worked it out together, to let him do it. This was

not making the workman the designer, because if he designed the work, it would probably not harmonise with its surroundings; it was the architect and the craftsman working together. The architect should be well acquainted with all the various arts, should have studied them at home and abroad, and should be an accomplished critic upon them, but he should not expect to be a better designer in ironwork than the iron workers, or in wood carving than the carver. What he had said about ironwork applied to wood carving, and all the other arts which assisted architecture. The only way to have good work was to see that you had good workmen; when that was recognised, there would be a good time for the art workman, who would no longer be ground down, but would feel that he was making a name for himself, and would take a pride in his work accordingly. He had always found that the man who, the moment you suggested any improvement, began to talk about the extra work there, and the length of time it would take, would never turn out good artistic work, but the one who recognised that the thing had to be done well, no matter what time and trouble it involved, would generally give satisfaction.

The CHAIRMAN said this paper must have stimulated thought in all who had heard it, and the discussion had shown that amongst both workmen and employers there was a feeling of agreement with what had been said. He did not feel quite sure, himself, from the paper, how bad things were, or how much hope there was, but he should go away with his mind full of the subject, and so would others, and as the result, some good must arise. He did not suppose there was a man in England who loved his art more than Mr. Crane, and one of the main lessons of his paper was to make the best of every possibility. Money would help, but it should not retard; it had taken a great deal of money to carry out his own little arrangements, and he did not know what could be done without it. They had heard a great deal about employer and employed; times had certainly changed somewhat, but he still remembered painfully the years when a man (his father) waited, struggling for his genius to be discovered, and no one came to him. He was a remarkable carver, and would have done anything which Mr. Payne suggested, but no one came to him, and he had no opportunity of showing his skill. He came to an unfortunate town in England and there he stuck. This was before the Exhibition of 1862, which caused a great improvement in taste; he made a cabinet with great difficulty, and had to alter the design of the crown of it, because he had not enough wood and could not buy any more, and for this beautiful work, which would readily fetch 100 guineas or more now, he could not get £5. How was such a man to become known in England? In Germany there were many such artistic workmen, and as they clustered together in small towns they were known and were easily found. He was building a tower in a small town of about 5,000 inhabitants, in which there were at least three first-rate artistic iron workers, and one excellent stone carver, who not only knew how to build in brick and stone, but was a first-rate ornamental stone carver. With regard to the unfortunate word "degrading," he had not the slightest idea whether he used it or not in talking to his Whitechapel friends, but if he did he only meant it in respect to the man's powers to whom he was referring to. He was a remarkable artist in the best sense; he went through the fine old school of apprenticeship, and was conducted thrice to school on Sundays with his comrades, that is, to the Sunday-school, the day-school, and the drawing-school, and at the latter he obtained the only medal given in the year, which was presented him by the Mayor in the town-hall. He then travelled on foot through Europe, going to Amsterdam and Paris, and thence home to Munich, where having made his masterpiece he set up as a master. For reasons which it was not necessary to describe, Germany was too narrow for him, and he went to America, and there, instead of carrying out the art work which he ha hoped, and for which he knew he had the ability, he had to do this degrading work, to him, in order to get a living. Taste in those days in America was a little serious. He and his brother even took to portrait painting, but the applied arts were most in demand, and so they had to make figure-heads and brackets for houses; to make them into stone they covered them with sand. That work was degrading to such men, but how were they to live while they were waiting to be found out. The necessities of life were very hard. He spoke very feelingly, having seen this great man living on with the painful feeling that he could not do the work which he felt he had the power do. Later on he had been able to do it, through his (the Chairman's) success in art, but that did not affect the question of the paper, and a very pressing question it was, how was the art workman to be recognised? Prizes might do something, and he hoped they would. They all knew the use and abuse of machinery. Some things must be perfectly accurate, and for them machinery was suitable; but in art there were certain irregularities—he would not call them imperfections—which added a charm. He had just been to Manchester, where he had been much charmed by some pictures by Frederick Walker, in which you saw the struggles of the artist to express himself. It might be the question of a hand without fingers, fitted on to the body of a boy so far finished that even his eyelashes were painted in. He was now having some curtains woven by a brother of his father's in a hand-loom, in which there would necessarily be the imperfections of such a work, but there would be the charm of the eyelash and the rough hand in it. That was one thing which he wished Mr. Crane had answered, why it was that, except in the great domain of commercial articles, there was nothing later than the 16th century in any form or shape which was not hideous. It was a curious thing that the com-

mercial element should have so destroyed the natural beauty of things. With the increase of population, and the widening out of the social body, different methods had to be used, and so they had seen the necessity of introducing machinery to do that which the hand could not do so well. Enthusiasm was a great power, but good work was sometimes done without it. The most remarkable firm for silver work which he had visited was Tiffany's, in New York, where everything was done in the most beautiful and perfect way. Here he saw a number of the most charming and beautiful things possible in *repoussé* and chased work; but when he asked the manager if the men liked their work, his reply was that they did not care a cent for it. He was terribly disappointed at this, and of course he could not say what was the cause; it might be the hard bargains their employers made with them, or it might not. In America, his uncle had employed carvers for thirty years, but he always found that the cleverest men were the most unreliable. The best workmen would work hard for perhaps six weeks, and then go off on the drink. These were the men who could stamp their individuality on their work. Many carvers were very different, and he could quite sympathise with what had been said by one of their number, who, he could see, would like to do some work of his own, but who felt hardly able to move, and probably had a family and looked with anxiety to every Saturday night. Times were undoubtedly bad; people did not order what they ordered before; though he went so far as to say that you could not order the best things; you must make them, and if you made them you must give them away, for you could not sell them. That was perhaps an exaggerated form of putting it, but he had not studied the commercial side of the subject as Mr. Crane had. He had an apprentice, a Scotch boy, who had never studied drawing; he was a gardener's son who was recommended to him, and he gave him some wood and tools to see what he could do, and in a very short time he saw that he would make a first-rate wood carver. He allowed him to take outside work, and he got an ornamental cross to make for the parish church. One day he found a charcoal design for this cross, and asked his uncle if he had drawn it, but he said no, the boy had done it himself, and it had all the finish of a designer's drawing. He had absorbed all he had seen in a year and a-half, and when the necessity came he was able to make use of it. He should say, therefore, that all workmen should have opportunities, and if they succeeded, they should be encouraged, but it was a great point only to accept work which was really good. In that way they would find out whom nature intended to be designers, and he wished Mr. Crane had laid a little more stress on the importance of nature's gifts. He had been rather hard also on the painters; they were not quite so bad as he made out, especially considering that they were driven by an unalterable state of things, such as an annual exhibition and the shortness of memory of the public. They lived but a short time, and wished to make their mark, for they were all ambitious, or ought to be, and thus came the necessity for being ready rather than being right. He could not compare himself with others, having begun as a craftsman and become a painter afterwards, but they had difficulties and trials of which designers had no conception. There were moments when painters might turn their hands to other things, which would be much better than going out into ridiculous society; not that he disliked society of the right kind, but painters should have the power of making a society of their own. Still, they might do other work, if it was only painting tiles. In conclusion, he proposed a hearty vote of thanks to Mr. Crane, to whom he felt personally indebted for his very thoughtful and suggestive paper.

The vote of thanks having been passed unanimously,

Mr. W. CRANE thanked the audience for their sympathetic attention, and said he was glad to find that his paper had provoked so much discussion, but probably the remarks of the Chairman had done still more in that direction. It seemed to him that after all the great sphinx question of economy could not be shirked; it seemed a somewhat dry subject, but until it was settled they would remain puzzled as to the reason of the difficulty they found in producing good art, and why things had declined so terribly since the 15th century. On looking a little into history, very clear reasons for that would be found in the gradual change which followed the rise of the great commercial class which now ruled society, for although we dwelt under the forms of political liberty, we really lived under a tyranny, and this was beginning to be found out. The Chairman had spoken of the artistic man being less reliable than he who went plodding on. He did not know if it were true that the artistic character was less reliable, but if so, it was quite as it ought to be. It only meant that the artistic character was not so easily made a slave of, and as long as there remained any artistic gifts in humanity, they would be less reliable in that sense. The only chance for progress was, that there were a certain number of men prepared to kick over the traces at any moment. The Chairman also said that art should be given away, and that was quite true. If the artists had some other means of making a living, they would be delighted to give their art, and then the only art would be that which was a pleasure to the doer, and that was the only art worth having. All agreed that art could not be produced to order, or for any other reason than for love, and, therefore, it must be given away finally. There were notorious instances of the enormous rise in the price of pictures, but the artist did not get any of that. He sold his picture in the first place, perhaps, when he was an unrecognised man, for a very small

sum, just enough to cover his expenses of living while doing it, so that he gave it for love quite as much as if he did not receive a penny for it. The true solution, which would have to be found sooner or later, was a re-organisation of society, and then the reform of art would settle itself. This was the Aaron's rod which swallowed up all the others. They must get on somehow in the meantime, and it was somewhat promising that there should be this desire on the part of the workman to make himself felt, and on the other side, too, to call for the recognition of the workman to make work rest on its true basis. As to machinery, he agreed that there was a charm in that irregularity, which the Chairman had refused to call imperfection, and if a moulding were carved out it had a beauty which could never be attained by machinery. Machinery could never rival the human hand and brain working together; machinery at best was but an extra development of fingers and toes, and perhaps brain, man having developed in that direction instead of throwing out horns and hoofs. Everything seemed to point to the conclusion at which he hinted in his paper, but it was too large a a subject to deal with in such limits, or perhaps in connection with art at all, but those who look to the future (and all must look either forwards or backwards), must look to an entire change in the basis of society, and the system of the production of wealth—in short, to some system of communism. Certainly, in modern times, society was much more capable of re-organising itself on a communistic basis. The nationalisation of wealth would remove all the difficulties. They must all set their best wits to work in order to get rid of the tyranny of a class which used the means of production solely to enslave its fellow creatures for the greed of gain.

Miscellaneous.

CATHEDRAL OF FLORENCE.

The following report by Consul-General Colnaghi, on the unveiling of the façade of the Cathedral of Santa Maria del Fiore, has been forwarded to the Council of the Society of Arts by the Marquis of Salisbury, K.G. (Secretary of State for Foreign Affairs), for publication in the *Journal*:—

Florence, May 13th, 1887.

My Lord, —Yesterday morning, at 10 o'clock, the new façade of the Cathedral of St. Maria del Fiore was unveiled in the presence of their Majesties the King and Queen of Italy, and his Royal Highness the Prince of Piedmont, the Representatives of Foreign Powers, of the Senate and Chamber of Deputies, all the local authorities, and a great concourse of people. When the veils had fallen, the Archbishop of Florence, attended by his clergy, blessed the work. At the termination of the Benediction, one hundred pigeons were set free to carry the news to the various cities of Italy. The morning was fine, and the ceremony passed off most successfully, the reception of their Majesties being very enthusiastic.

At 2 p.m. a Te Deum was sung in the cathedral, the King and Queen walking up the centre aisle, accompanied by the Archbishop, and followed by the clergy.

The Cathedral of Florence, Santa Maria Del Fiore, is declared by Fergusson, in his History of Architecture, to be among the greatest and most complete examples of Italian Gothic. Almost perfected in its other parts, the façade had never been finished. That portion said to have been erected after the designs of Giotto, and enriched with sculptures by Donatello and other masters, had been destroyed, and no permanent structure had taken its place. An interval of 145 years had elapsed since the last attempt had been made to complete the front, when public attention was, once more, called to the subject by Signor Giovanni Silvestri, who, in 1833, published a design for the façade. Ten years later, the Cavaliere Nicolo Matas, who afterwards designed and completed the façade of the Church of Sta. Croce, exhibited a colossal design of his invention at the Palazzo Vecchio. The idea was favourably received, and between 1843 and 1855, several other designs were brought out. Finally, in 1858, a committee was appointed, under the auspices of the Grand Ducal Government, and the Hereditary Grand Prince of Tuscany at its head, with the title of "Deputazione Promotrice," to collect subscriptions for the work, which it was seriously intended to undertake.

The political events of 1859, however, put a stop to the proceedings, but not for long. The "Deputazione" was reconstituted by Decree of the Governor General of Tuscany, dated April 18th, 1860, when his Royal Highness the Prince of Carignan was named its President. The Syndic of Florence (Vice-President), the Presidents of the Chamber of Commerce, and of the Academy of Fine Arts, and the Director of the Board of Works were appointed *ex-officio* members, other Florentine noblemen and gentlemen being selected to complete the full number of eleven, including the Secretary and Treasurer. The "Deputazione" delegated its administrative functions to an executive committee of nine members, who have paid unremitting attention to the great work. A consultation council, composed of thirty-six members, was also appointed.

The first public act connected with the new façade was the laying the first stone by King Victor Emanuel, on the 22nd of April, 1860. The difficulties connected with the selection of a suitable design next began. Were it even advisable, it would occupy too much space to recount the vicissitudes of the several competions. The jealousies excited, the controversies raised by the clash of conflicting

opinions have hardly yet died out, nor is there any necessity to revive them. The general results arrived at on each occasion are all that need be set down here.

Towards the close of 1862, the first competition—public and international—at which architects were invited to present designs for the proposed façade of the cathedral, was held in Florence. Of the designs presented, more than forty in number, some were highly commended, those of Messrs. Ceppi, Falcini, and Peterson, the last a Danish architect, receiving prizes, while others obtained honourable mention. The jury, composed of the professors of architecture at the seven principal Italian academies of fine arts, did not, however, consider any design as suitable for execution, and no award was made.

The public competition having thus failed of its object, the "Deputazione Promotrice" determined to pursue another course, and to invite a limited number of architects to send in designs for approval. The second jury, consisting of six members, of whom two were foreigners, selected, by four votes to two, the design of Professor E. de Fabris, a Florentine, as worthy of being carried into effect, subject to some modifications in points of secondary importance. The report is dated January 26th, 1865. This decision raised so much adverse criticism on the part of the Press, that the "Deputazione" felt bound to seek for further advice before coming to a final choice. In November, 1865, it was decided to have another trial, and a fresh jury of nine members, of whom three were foreigners, was appointed. Their report on the designs sent in, by invitation, on this third occasion, dated July 25th, 1867, confirmed, by five votes to three (one juryman being absent from illness), the award of the previous jury.

After some further deliberation the "Deputazione" accepted Signor de Fabris' design, by five votes to four, on the 27th June, 1868, and he was finally appointed architect of the façade, Signor L. del Moro being named his assistant.

In 1871, the plaster carving, which, it can hardly be said, decorated the façade of the cathedral, was removed, but the preparatory works for the new front were not commenced until the 15th of August, 1875, owing to Ministerial interference with the position held by the "Deputazione Promotrice" as director of the undertaking. All difficulties having at last been overcome, the actual construction of the façade was begun on the 1st of January, 1876.

The first official estimate for completing the façade, exclusive of the bronze doors, was £60,000, but the total cost of the work has not exceeded £37,500, or £22,500 less than the estimate. The saving effected is worthy of special notice, and reflects the greatest credit on all concerned in the execution of the work. In order to obtain this result, the most careful management was necessary, and economy was strictly carried out in every detail, beginning with the remuneration granted to the architect and his assistant, who received respectively £200 and £96 per annum. The stone cutters of Florence and its neighbourhood, still imbued with the artistic feeling of the Middle Ages, are distinguished for manual capacity and native intelligence. Of such men a band of workmen was gradually formed, under the management of Signor Angiolo Marucelli, surnamed "Campino," who was appointed foreman of the workmen, and who was assisted by his two sons, Zuliano and Gabriello. The Tuscan sculptors vied with each other in executing the statues and medallions required for the façade, for their working expenses only. Professor Barabino, in like manner, executed the cartoons for the lunettes over the portals, which have been carried out in mosaic by the "Societa Musiva" of Venice, on very easy terms. Mr. Henraud, the proprietor of large marble quarries at Serravezza, offered the white marble required at cost price, which reduced the expenses on this article about 50 per cent. The usual prices were paid, however, for the red and green marbles used. The stone employed in the building was supplied gratis from the municipal quarries of Monte Ripaldo. The ornamental carvings, the inlays, and the decorative mosaics, were entirely carried out on the works.

The average total number of hands employed per annum, such as masons, labourers, stone cutters, sawyers and polishers, but exclusive of smiths, carpenters, carters, &c., was eighty; the rates of daily wages paid were as follows:—

	s. d. s. d.	s. d.
Foreman of Works	4 0 to 4 10*	
Ornamental Sculptor, Mosaicist and Inlayer	2 5 to 4 0*	
Masons	2 1 to 2 7	average 2 3
Labourers	... ...	,, 1 5½
Stone cutters ... ..., Polishers ... ., Sawyers	1 7½ to 2 10	,, 2 2½

The day's work was nine hours in winter and eleven hours in summer, or an average of ten hours for the year. Wages were paid weekly. No piece work was given out, the men working for daily wages under the supervision of the foreman. The general superintendence of the works was retained by the architects in their own hands.

The marbles used for veneering the façade were:—White.—Serravezza, second quality; the same being used for the statues and decorative work. Green.—Verde di Prato, from the quarries of Monerrato. Red.—Of two qualities, for plain slabs from the quarries near Montieri, for mouldings from the Gerfalco quarries, both in the province of Siena.

The new façade is divided into three parts, corresponding to the nave and side aisles of the interior. It comprises three richly decorated portals, of which the centre is the most important. The apex of the pointed Gothic canopy which decorates the latter is surmounted by a statue of the Virgin with the infant Saviour in her arms, set in a richly decorated tabernacle forming the centre of a series of niches,

* Raised during the course of the works.

which extend along the whole front, and contain colossal statues of the twelve Apostles. The upper part of the central division of the façade, which rises to the roof of the nave, contains a fine rose window, while smaller windows, on a lower level, surmount the side portals. The walls are veneered with white, red and green marbles, disposed in panels over the surface, as on the rest of the building, and the projecting gallery with pierced parapet resting on corbels, which is carried along the sides and round the octagonal choir of the church, is continued along the façade. The fine bas relief filling the tympanum of the central portal, and representing the Madonna in glory with other figures, is by Professor Augusto Passaglia.

The original design of Signor de Fabris was, in Italian nomenclature, "Tricuspidale," that is, following the examples set in the cathedrals of Orvieto and Servia, where three triangular gables, flanked by decorated pinnacles, crown the edifice, and rise above the structural lines. This termination met with much adverse criticism, and the architect, against his own judgment, obeyed instructions to prepare an alternative plan in the style termed "Basilicale," that is, following the lines of the building, the two side gables being omitted, and the centre one modified into a mere pediment.

Signor de Fabris, unfortunately, did not live to see his work completed; he died in June, 1883, when the building had progressed so far that it was ready to be unveiled to the public view that judgment might be given as to the style with which it should be crowned. The temporary unveiling took place on the 5th of December, 1883, in the presence of his Royal Highness the Prince of Carignan, the Archbishop of Florence, and all the local authorities. The façade, as far as it went, was completed in Basilical style, a temporary gable being raised over the north wing, the furthest from the campanile, to enable a comparison of the two styles to be made.

The artistic enthusiasm of the people of Florence was intense, and the interest taken in the controversy such that, for several days, nothing was heard in the streets, and in the cafés, but the words. "Tricuspidale" and "Basilicale," followed by expressions of approbation or the reverse, indeed, the more ardent supporters of the opposite opinions almost came to blows on the subject. The popular vote, supported by a majority of the artistic world, was given strongly in favour of the Basilical type, special regard being had to harmonising the façade with the lines of the campanile, with the effect of which it was considered the gables would interfere. Finally, official sanction was given to the change of plan, and it was determined that the façade should be "Basilicale." In this style it has been completed, Signor L. del Moro, the former assistant, having been appointed architect of the work, in the room of the late Signor de Fabris.

The cost of the façade has been entirely defrayed by subscription. The sums collected between 1859 and the beginning of 1867, including interest, amounted in all to about £8,060, of which some £5,500 were spent in preliminary expenses. The "Deputazione Promotrice" began the work in earnest in 1876, with only £2,500 in hand, and their faith has been justified by the result, all the remaining money required having been collected during the progress of the building.

On the first list of subscribers to the façade are found the names of Pope Pius IX, Victor Emanuel II., King of Italy, The Prince Eugene of Savoy-Carignan, and the Grand Duke Ferdinand of Tuscany. The subsequent lists show that the work has been carried out almost entirely by Italian and, in a very large degree, by Florentine subscribers. The principal foreign residents in Florence have not, however, withheld their offerings, the late Prince Demidoff and the late Earl of Crawford and Balcarres especially having put down their names for conspicuous sums.

The façade will be completed by the erection of bronze doors, the designs for which are now being exhibited. His Majesty King Humbert, on his visit to Florence in the autumn of last year, gave a sum of £4,000 towards the doors, the total cost of which is estimated at £14,000.

With the *fêtes* for the unveiling of the façade of the Duomo, the fifth centenary of the birth of the great Florentine sculptor Donatello, has been, not inappropriately, associated. Florence, for the last few days, has been alive with visitors, both Italians and foreigners, and the city has been gaily decked with flags, hangings, and flowers.

The festivities prepared for the guests of the city include a ball, in Mediæval costume, at the Palazzo Vecchio, an historical procession, a *carrousel* regatta, a gala performance at the Pergola, exhibitions, and congresses of various kinds, displays o fireworks, and a general illumination. Some o these are already of the past, others are still to come. The rejoicings will finally close on the 19th instant.

I have the honour to be, with the greatest respect,
My Lord,
Your Lordship's most obedient, humble servant,
D. E. Colnaghi.

The Most Noble,
The Marquis of Salisbury, K.G.,
&c., &c., &c.,
Foreign-office.

USEFUL PLANTS OF MAURITIUS.

Fibre-yielding plants flourish uncommonly well in Mauritius, as proved by the experimental culture at the Botanic Garden. Cotton is grown in very small quantity. The American aloe (*Agave Americana*) has been tried with success, and machinery adapted to the separation of the fibre. A local specialty in fibrous plants is the *vacoa* or *vacois* (*Pandanus*

odoratissimus), whose long tough leaves are thrashed out, and manufactured into bags for shipping sugar in.

The woods of the island show greater variety, but the supplies have been terribly curtailed by the destruction of the forests, to make room for sugar plantations. The principal timber trees are as follows:—Ebony (*Diospyros reticulata*) grows to a considerable size; olive wood (*Olea lancea*) is elastic and good for shafts, tool handles, &c.; *colophane* (*Colophonia mauritiana*), a large tree often attaining a diameter of 6 feet, gives a resinous heavy wood much used for cart-frames, wheels, shipbuilding, railway brakes, carriages, and wagons; ironwood (*Stadtmannia Sideroxylon*), almost indestructable in house building; several kinds of *bois de natte* from *Labourdonnasia spp.*, useful in all kinds of construction, and the barks good for dyeing and tanning; also the woods of *Jossinia lucida*, *Memecylon trinerve*, *Syzygium sp.*, *Mangifera indica*, *Heritiera littoralis*, and *Acacia alata*.

Correspondence.

KOLA NUTS.

Sir Augustus Adderley very much understated the following items of information, viz., the value of kola nuts, and the preparation of coffee in London; and Mr. D. Morris, the Assistant-Director of the Government Gardens, Kew, made matters worse by getting a letter from a well-known firm of druggists to support his criticism on the paper. Mr. Lascelles-Scott tried to set Mr. Morris right at the meeting, as he was working at this important article, and knew the facts of the case. In regard to the letter signed by Mr. H. Arnold (on behalf of Messrs. Burgoyne and Co.), he wrote to the best of his knowledge in regard to the fortnightly auction sales; but the fact is that kola nuts come to Liverpool, and are sold there; and when they come to London the brokers offer them direct to us, as they know we are the buyers. Besides these, quantities come to us and other consumers direct from the West Coast, and therefore do not appear on the market reports. This explanation is only due to Sir Augustus Adderley, who had evidently taken much pains to master the facts he placed before the Society.

The demand for *sound* kola is far beyond the supplies, and lately 1s. per lb. has been paid here for sound nuts for the whole parcel received. We have orders, which we are trying to execute, for 30 tons, and 100 tons would be taken if we could only get supplies of *sound* nuts, dried in the shade, at 5d. or 6d. per lb.

Kola chocolate is selling at 4s. per lb., and since it has been found of so much service in the hospitals, its regular use is ensured. We suffer in this country owing to the Government having no one to advise on such a food as this for the troops, and if I could have been present at the meeting, I should have said much more than you can afford me space for. Three of the Governments of Europe have ordered the preparation of the kola paste in quantity for army food. The experiments show that men can subsist on one ounce of kola for twenty-four hours, without the gnawing feeling of hunger and thirst, and when they can get food, they do not suffer from any inconvenience. This is thought to be due to the caffeine combined with the other constituents of the nuts, when mixed with a vegetable fat.

Wherever coffee has been found indigenous, it has been observed that the natives pick it and dry it in the cherry, or outer skin, and it is well known that this improves the quality, and the flavour is better retained, even for years. In many places merchants can command supplies of coffee in the form of "dry cherry," or in the "parchment," and some parcels in the cherry I sold to houses who roasted it with the outside jacket on, but as this required experienced roasting, the proprietors of the coffee warehouses saw the necessity, and ordered sets of the most approved coffee-dressing machinery, and erected them in London, and large quantities of coffee are treated here which command the full market price. During the last two months I have been seeking for some means of turning the large stock of coffee husks to some account, with the professional assistance of Mr. R. H. Harland, F.C.S, and of Messrs. Cross and Bevan; coffee dressers can find no use for these husks. The great advantage of this established enterprise is that the large companies opening up Africa can purchase the dried coffee in small quantities, and have it home in bags, and as soon as it arrives it can be sent at once to the warehouses to be decorticated, and placed on the market. Messrs. Major and Field, of Red Lion Wharf, allow me to state that in 1886 they decorticated 10,000 bags of coffee, and that in one vessel they received over 3,000 bags of coffee in the parchment to be decorticated. They further state that they have 100 tons of the husk which they would be glad to find a use for at a very low price. I hope that the readers of the Society of Arts *Journal* will be able to turn to account this information, and feel disposed to circulate it among their friends, as coffee has risen so enormously in price during the last few months.

In conclusion, I would like to put on record another fact, viz., that kola is being mixed with some of the preparations of coffee which enables the vendors to state that their mixture contains "no chicory," which is of great importance now that it is proved that the addition of chicory conduces to the growth of hæmorrhoids.

THOS. CHRISTY.

25, Lime-street, London,
31st May, 1887.

Obituary.

Francis Fuller.—Mr. Francis Fuller, one of the oldest members of the Society of Arts, died on Friday last, 27th May, at St. Aubyn's, West Brighton, aged 81. Mr. Fuller was elected a member of the Society in 1843. He was a member of the first Council in 1845-6, and served in successive Councils until 1850, when he was chosen as chairman, an office which he held for a few months. He took a prominent part in the work of the Society connected with the initiation of the Great Exhibition of 1851, and in conjunction with the late Sir Henry Cole, reported to the Prince Consort on the preliminary arrangements. He also acted with Sir Henry Cole and the late Mr. Scott Russell as a committee for making arrangements with the contractor, and was appointed a member of the executive committee of the Exhibition, the chief portion of his work being devoted to the collection of subscriptions in the early stages of the undertaking, but he retired when the Royal Commission undertook the active management of the Exhibition. He was managing director of the Crystal Palace during the progress of the works and for a short time after the opening, on May 10th, 1855. In March, 1871, Mr. Fuller took the chair at a meeting when Miss Emily Faithfull read a paper on "Woman's Work," but of late years he had not been a frequent visitor to the Society.

General Notes.

Gas Institute. — The Twenty-fourth Annual General Meeting of the members of the Gas Institute will be held at the Corporation Galleries, Glasgow, on Tuesday, Wednesday, and Thursday, June 28, 29, and 30. The Glasgow Corporation Gas Works will be visited on Wednesday.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 6...Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. R. M. Bancroft, "Renewal of Roof over Departure Platform at King's-cross Terminus, G.N.R."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. H. E. Armstrong, "The Alkaloids: the Present State of Knowledge concerning them, and the Method employed in their Investigation." 2. Mr. Boverton Redwood, "Notes of a recent Visit to some of the Petroleum-producing Territories of the United States and Canada."

Surveyors, 12, Great George-street, S.W., 3 p.m. Annual General Meeting.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. E. M. James, "A Journey through Manchuria."

Tuesday, June 7 . Royal Institution, Albemarle-street, W., 3 p.m. Rev. J. P. Mahaffy, "The Hellenism of Alexander's Empire." Lecture I.—Macedonia and Greece.

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 11, Hanover-square, W., 8½ p m. 1. Mr. A. O. Hume, "Remarks on certain Asiatic Ruminants." 2. Mr. Edmund Symonds, "Notes on some Species of South African Snakes." 3. Mr. Martin Jacoby.—List of a small Collection of Coleoptera obtained by Mr. W. L. Sclater in British Guiana. With the Description of a new Species, by M. H. W. Bates.

Wednesday, June 8...Geological, Burlington-house, W., 8 p.m. 1. Professor P. Martin Duncan, "A Revision of the Echinoidea from the Australian Tertiaries." 2. Messrs. A. J. Jukes-Brown and W. Hill, "The Lower Part of the Upper Cretaceous Series in West Suffolk and Norfolk." 3. Mr. Orville A. Derby, "Nepheline Rocks in Brazil, with special Reference to the Association of Phonolite and Foyaite." 4. Miss Catherine A. Raisin, "Notes on the Metamorphic Rocks of South Devon." 5. Mr. B. Kotô, "Some Occurrences of Piedmontite-schist in Japan."

Microscopical, King's College, W.C., 8 p.m. 1. G. Massee, "Monograph of the Genus Lycoperdon." 2. Professor T. Rupert Jones and C. D. Sherborn, "Remarks on the Foraminfera, with especial reference to their Variability of Form, illastrated by the Cristellarians."

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Anglo-Jewish Historical Exhibitions, Royal Albert-hall, Kensington-gore, S.W., 8½ p.m. Dr. C. Gross, "The Exchequer of the Jews of England in the Middle Ages."

Shelley, University College, Gower-street, W.C., 8 p.m. Dr. R. Garnett, "Lord Beaconsfield and Shelley."

Thursday, June 9...Metropolitan Association for Befriending Young Servants (at the House of the Society of Arts), 3 p.m. Annual Meeting.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly.

Royal Institution, Albemarle-street, W., 3 p.m. Rev. J. P. Mahaffy, "The Hellenism of Alexander's Empire." Lecture II.—Egypt.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, June 10...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. Thomas Hodgkin, "Aquileia the Precursor of Venice."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. W. Poell, "Shakspere as a Playwright."

Saturday, June 11...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Dr. Warren de la Rue, "Exhibition of Puluj vacuum tubes." 2. Professors Ayrton and Perry, "Note on Beams fixed at both ends;" and "Note on Magnetic Resistance."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Rev. J. P. Mahaffy, "The Hellenism of Alexander's Empire." Lecture III.—Syria.

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FRIDAY, JUNE 10, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ALBERT MEDAL.

At the meeting of the Council on Monday last, 6th inst., a letter was read from the Secretary of His Royal Highness the Prince of Wales, the President of the Society, informing the Council that Her Majesty the Queen had intimated to His Royal Highness her willingness to accept the Albert Medal. It was offered to Her Majesty by the Council, with the approval of H.R.H. the President, in this the Jubilee year, in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of Her reign.

MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of papers during the Session 1886-7:—

To A. Gordon Salamon, for his paper on "Purity of Beer."

To William P. Marshall, for his paper on "Railway Brakes."

To Dr. Percy Frankland, for his paper on "The Living Organisms of the Air: the Effect of Place and Climate on their prevalence."

To A. Reckenzaun, for his paper on "Electric Locomotion."

To Mrs. Ernest Hart, for her paper on "Cottage Industries in Ireland."

To T. Armstrong, for his paper on "The Present Condition of Applied Art in England, and the Education of the Art Workman."

To J. Starkie Gardner, for his paper on "Wrought Ironwork."

To Walter Crane, for his paper on "The Importance of Applied Arts, and their Relation to Common Life."

To Allan Ransome, for his paper on "Colonial Woods."

To Richard Bannister, for his paper on "Colonial Wines."

To Dr. George Watt, C.I.E., for his paper on "The Economical Condition of India."

To Holt S. Hallett, for his paper on "New Markets and Extension of Railways in India and Burmah."

Thanks were voted to the following members of the Council for the papers read by them:—

To William Anderson, M.Inst.C.E., for his paper on "Purification of Water by Agitation with Iron and by Sand Filtration."

To William Henry Preece, F.R.S., for his paper on "Fifty Years' Progress in Telegraphy."

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 15th June.

Each member has had sent to him a card for himself, which is not transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each. Not more than four tickets will be sold to any one member, and not more than 2,000 in all. When 2,000 have been disposed of, the issue will be stopped.

Tickets will only be supplied to persons presenting members' vouchers (which can be obtained from the Secretary), or a letter of introduction from a member.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary. In all cases of application by letter, a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman.

Light refreshments (tea, coffee, ices, &c., will be supplied. No refreshments can be obtained by purchase.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

Proceedings of the Society.

INDIAN SECTION.

Friday, May 27, 1887; Sir ROPER LETHBRIDGE, C.I.E., M.P., in the chair.

The CHAIRMAN, in introducing Mr. White, said this subject was specially interesting to all connected with the Indian Empire. The tea industry was one of which the British race might be proud. Its history in the past, especially in the immediate past, illustrated in a remarkable degree the pluck and industry of the British race, and its prospects for the future were such as must make the consideration of it of very great interest to all who had at heart the welfare of the British Empire. For the exposition of this very interesting subject, he had much pleasure in introducing Mr. Berry White, who was undoubtedly the first living authority upon it. His early life had been spent very largely in Assam, which had been the pioneer province of tea industry in India. For many years he was in medical charge of one of the most important districts in Assam, and in that capacity he obtained a very full knowledge of the cultivation of the tea plant. Whether tea be considered from a botanical, agricultural, or commercial point of view, no one was more qualified to expound the whole matter than Mr. White: and if he chose rather to confine himself to the commercial aspect of the subject, as he rather anticipated, he had no doubt he would furnish good reasons for doing so.

The paper read was—

THE INDIAN TEA INDUSTRY: ITS RISE, PROGRESS DURING FIFTY YEARS, AND PROSPECTS CONSIDERED FROM A COMMERCIAL POINT OF VIEW.

By J. BERRY WHITE,
Bengal Medical Service, Retired.

I presume that it was owing to this being the Jubilee year, not only of our Gracious Sovereign's reign, but also of the Indian tea industry, and of the consolidation of Assam, the great tea province of the empire, under British rule, that the Council of this Society, who have done so much in the past to foster the enterprise, considered it to be an appropriate occasion for a review of the prospects and position of the industry being made by some competent authority, and that, with this view, application was made to the Indian Tea Districts Association to nominate one of their members to read a paper on the subject before the Indian Section of the Society.

I have not been able to devote sufficient time to the collection and compilation of comprehensive statistics illustrative of the rise and progress of the industry; but the limited figures and facts which I shall place before you this evening, if incomplete, are reliable.

I will confine myself to dealing with the economical, or commercial side of the subject; I will not attempt to discuss the agricultural or manufacturing processes as followed by tea planters in India, and which differ in many respects in the various districts. Many excellent essays and papers on such details are to be found in the *Journal* of this Society, and of the Agri-Horticultural Society of India; and a very excellent collection of extracts from all that had, up to that time, been written on the subject, was published in 1881, by the proprietors of the *Indian Tea Gazette*, under the title of the "Tea Cyclopædia."

I will, however, give a hurried glance over the origin and history of the industry. The suitability of the soil and climate of some parts of India for the culture of the tea plant was a frequent subject for discussion and report as early as the latter part of the last century and beginning of this, between the civil and medical officers of the East India Company, the Government of India, and the Court of Directors; but until 1834 these investigations and reports never got beyond a scientific or academic character. That nothing practical resulted from them was not the fault of the officers in India or of the local Governments, but was due to the fact that the Honourable Court in Leadenhall-street did not care to encourage a rival, even in their own territories, to the China tea trade, of which they held a monopoly up to 1833. The loss of this monopoly, on the renewal of their charter in that year, quickened their perceptions to the advantages likely to accrue to India by the establishment of a new industry, and in 1834 the Court sanctioned the appointment of a committee to consider and submit plans for the introduction of tea culture in India, and for the superintendence of such plans if approved. This committee was composed of seven officers of the Civil Service, either of high standing or of known ability, one medical officer, a distinguished botanist, three Calcutta merchants, and two native gentlemen. The last survivor of this important historical committee, Sir Charles Trevelyan, has only recently passed from amongst us.

Of the proceedings of this committee it is unnecessary to refer at any length; suffice it to say that their exertions at first were concentrated on carrying out the preconceived view of their most active member, Dr. Wallich, which was to import plants and seeds of the *Thea Bohea* and *T. Viridis* from China, and make experimental plantations upon the slopes of the Himalayas. But before they had been constituted many months their labours took a new phase, owing to the discovery—so called—of the tea plant as an indigenous growth in the Assam jungles.

A good deal of angry controversy has taken place as to whether Lieut. Charlton or Mr. C. Bruce was the first discoverer of the tea plant in Assam. Both have had their partisans, both received rewards, while, as a matter of fact, to neither of them belonged the honour. Some years prior to either coming to the Provinces, Mr. David Scott, the first Commissioner of Assam, had brought the existence of the tea plant in Assam to the notice of the Government of India, but whether it was the true tea plant was disputed; the doubt was not then set at rest, and the matter was lost sight of for some years. The credit of having established it as an incontrovertible fact belongs to his successor, Captain (afterwards General) Francis Jenkins, an officer whose eminent abilities, both administrative and scientific, have been rarely equalled, even in the grand old Indian services, and whose memory is now justly venerated, not only by those who knew him, and who, like myself, had the honour of serving under him, but also by the natives of every race and creed now inhabiting the Province. The Tea Committee had not met a dozen times before their attention was called to this fact by Captain Jenkins. Dr. Wallich pooh-poohed the discovery, and pronounced the specimens, both of leaves and fruit sent from Assam, not to be a true *Ternstrom*, but some other member of the camellia family. Francis Jenkins was not the man to be silenced by the snub of an expert; himself an accomplished botanist, he insisted that the plant was a true *Ternstrom*, and that its leaves made the true tea of commerce, and was in common use as such by all the Indo-Chinese tribes inhabiting the hills bordering the Provinces. His insistance at last bore fruit; his opponent, Dr. Wallich, was convinced, and the Governor-General, Lord William Bentinck, ordered a deputation to proceed to Assam, and collect, in the words of the resolution, "on the spot the greatest variety procurable of botanical, geological, and other details which, as preliminary information, are absolutely necessary before ulterior measures can be successfully undertaken for the cultivation of the tea shrub of that country."

The deputation consisted of Doctors Wallich, McClelland, and Griffiths, names that will be imperishable so long as the sciences of botany, geology, and natural history are cultivated, and whose researches shed lustre and distinction on the old Indian medical service, to which it is my greatest pride to have once belonged. Their journey from Calcutta to Sadiya occupied from August 29th, 1835, to the 9th January, 1836, exactly four months and ten days. The distance can now be traversed in a little under five days; a difference which I may remark, *en passant*, is wholly due to the development of the tea plant, which was the subject of this mission. Having visited several tracks around Sadiya and in the Upper Muttak country, where the *Thea Assaminensis* was found by them growing in luxuriance and profusion; they reported to the effect that it was undoubtedly a variety of the true tea plant of China, which had, however, degenerated by neglect of cultivation, and the wild conditions under which it was found in Assam, and wound up with the recommendation that the cultivated plant should be imported from China.

By this recommendation, these scientific gentlemen committed unwittingly the greatest possible injury they could do not only to the future of Assam, but to the prospects of the industry they were commissioned to promote. The importation of the China tea plant into Assam was in its way as disastrous to that province as the potato fungus has been to Ireland or the black bug to Ceylon.

The *Thea Bohea* of China is a shrub with small leaves, in size and appearance somewhat resembling the privet of our hedgerows. The *Thea Assaminensis* is a tree growing from 25 feet to 35 feet high, with leaves six times larger than the China variety. Under like conditions, the yield of leaf from an acre of Assam tea will be not less than double that of the China plant, and the gain is not only in increased quantity but the quality will, *cæteris paribus*, realise from 1d. to 2d. per lb. more in Mincing-lane than the smaller quantity made from the China plant.

In compliance with the recommendation of the deputation, immediate steps were taken to collect seeds and plants from China, and some were at once sent from Kumaon (where experi-

mental gardens had been formed some time before) for propagation in Assam.

The first experimental plantation in Assam was commenced at the latter end of 1835, and an extraordinary mistake was made, such as appears to be inevitable with all new enterprises. The land selected was at Sadiya, on a char near the confluence of the Koondil and Bramahputra rivers. It was a mere shifting sand-bank with a crust of a few inches of alluvial deposit, and the plants of course died so soon as their tap roots reached the sand. In fact, the scientists selected the only patch of soil a furlong square in Upper Assam, in which tea would not grow and thrive. The garden proved a lamentable failure, and within a few years the Bramahputra flowed over its site.

The next attempt was more successful, a garden was commenced in 1837—just fifty years ago—at Chabwa, 18 miles from Dibrugarh, a place where indigenous tea had been found. It is a matter for profound regret that this garden did not share the fate of its predecessor, for it proved the chief means of disseminating the pest of Assam—the miserable China variety—all over the province, not only by means of seed, but, owing to its prolific inflorescence, the indigenous Assam plants in the vicinity were impregnated with its pollen, and thus produced the hybrid variety which now forms the great bulk of the plant found not only in India but also in Ceylon. It may be of interest to note that the Government, after a short time, made over Chabwa for a nominal consideration to a Chinaman, who in turn sold it for a few hundred rupees to the late Mr. James Warren, and after many vicissitudes, and the China plant having been in a great measure extirpated, it has become a profitable garden, the property of a limited company of the same name (Chabwa.)

The selection of Kundil Mukh was not the only mistake made by Government in their initial efforts to establish tea culture in Assam. Acting presumably on the belief that every Chinaman must be an expert in tea cultivation and manufacture, they transported all the Chinese shoemakers and carpenters that they could induce to go from Cositollah and other bazaars in Calcutta to Assam; these men were nearly all from the sea-port towns of the Celestial Empire, and many had never seen a tea plant in their lifetime. Some of these poor creatures were still in Assam when I first went to the province in 1859.

While these experiments were being conducted, Upper Assam, the natural home of the tea plant, was still foreign territory, under a native ruler, Porundur Singh, the British maintaining there a few troops and a political agent. In 1839, in consequence of failure in fulfilling his treaty engagements, the native ruler was deposed by Colonel White, our political agent at the time, who then took over the direct administration of the districts of Sibsagor and Lakhimpur in the name of the British Government.

This annexation made private enterprise possible and safe, and a few months afterwards saw the formation of the Assam Company, to whom the Government made over all its experimental plantations, excepting Chabwa, as already stated. At the outset the Assam Company was not much more successful than the Government had been, the mistakes it committed were, if possible, more egregious, and in a few years it had expended its entire capital—£200,000, and was practically bankrupt, a committee of its shareholders having considered the propriety of going into liquidation; the sale of a steamer and some other realisable assets enabled it, however, to go on under better management both in Assam and Calcutta. The tide then turned, profits at last flowed in, it paid its first dividend out of earnings in 1852, and the Company has now for many years, with the exception of two or three disastrous or panic seasons, realised splendid profits, having divided among its shareholders over a million sterling, and its property is now worth, valued by the selling price of its shares this month, nearly half-a-million.

For the first decade after its formation the Assam Company held a virtual monopoly of tea cultivation in India. It was a period mostly of disastrous experiments, which others did not care to share, but as the prospects of the industry improved, some of the former officers of the Company and others opened out gardens upon their own account. In 1853 there were nine private gardens in Upper Assam, and in the following year gardens were opened out in Lower and Central Assam, and in 1855 the first gardens were commenced in Cachar and Sylhet; in these districts indigenous tea had also been found extensively. In 1858 the Jorehaut Company was formed out of the estates of the Messrs. Williamson, and was from the first a brilliant success, and has since its formation paid handsome dividends, excepting one or two years, the aggregate averaging over 15 per cent.

So far, I have not referred to districts beyond

Assam. Tea cultivation has, however, made considerable progress in some parts of Bengal, the North-West Provinces, the Punjab, and Madras.

Darjeeling is the first of these in importance. Here tea cultivation was commenced in 1858-9, under the fostering encouragement of the chief Government official, the late Dr. A. Campbell. With its subdivision known as the Terai, its estimated out-turn for the current season is given as nearly 9,000,000 lbs. The tea from this district is of peculiarly fine taste and flavour, unrivalled elsewhere. On this account it has less to fear from competition than districts more highly favoured in other respects, but which do not produce tea of special excellence. Its tea, in fact, bears the same relation to other teas as Lafitte does to the ordinary brands of claret.

The Western Dooars, a district annexed from Butan in 1862, is contiguous to Assam, and has many of the advantages of soil and climate of that province. The first garden was opened out about ten years ago, and cultivation has rapidly extended; it promises to become soon one of the most important tea districts of India. The yield per acre is very large, labour is comparatively cheap, and the cost of production is consequently low, but its teas have no especial merit or characteristic. Its out-turn in 1884 was 2,750,000 lbs., and the estimated production of the coming season is returned at over 4,000,000 lbs.

Chittagong and Chota Nagpur started tea cultivation about 1867. These districts possess no special advantages as regards soil or climate, but labour is much cheaper than in Assam, especially so in Chota Nagpur. The two districts are expected to produce 1,500,000 lbs. this season.

Kumaon is interesting, from being the cradle of the early attempts to establish tea cultivation in India, before the plant was discovered in Assam. For some years the industry in this district has been stationary. It made, in 1884, nearly 500,000 lbs., a moiety of which was green tea.

Kangra valley produces under 1,500,000 lbs. of very delicate flavoury tea, which, however, does not command a remunerative price in London. Nearly one third of its out-turn is green tea, which is mostly exported beyond the frontier.

Dehra Dun has been the seat of tea cultivation since 1842. It has not made any material progress in recent years. The annual out-turn is about 780,000 lbs., the soil and climate appears to be better suited to the production of green than of black tea. The future of the tea districts of the Panjab and North-West Provinces would appear to lie in the possibility of their opening up markets locally or in Central Asia. Should values fall still further, it will be impossible for these districts to place tea on the London market without serious loss, judging from the financial statements of the local companies whose current accounts are published.

In South India tea is grown in the Neilgherries and Travancore. The produce of the former possesses all the fine flavouring characters of hill teas, but the planters there having a more remunerative crop in coffee with the working of which they are familiar, have never pushed tea cultivation with energy. Travancore has only recently been opened out for tea. As it has a nearly similar climate to Ceylon, with far better soil and cheaper labour on the spot—if tea cultivation eventually proves to be remunerative in the island, it should be still more so in this State.

Tea is grown upon one estate in Arracan, and attempts on a small scale have been made in other parts of Burma. The quantity produced is extremely small, and finds a local market. Owing to the high rates of labour and other disadvantages, there is very little prospect of tea cultivation extending in any part of Burma.

I digressed from the history of tea in Assam to notice, hurriedly, the other tea districts of India, but it is in Assam alone, with the adjoining districts of Darjeeling and the Dooars, that it posseses any real commercial importance. I left off at the establishment of the Jorehaut Company, in 1858, and during the four following years, cultivation extended rapidly in every district of the province, excepting Goalpara. The conspicuous success of the Assam and Jorehaut companies led, in 1862-63-64 to a period of wild excitement and speculation; clearances were made without any provision for labour to keep them in cultivation; companies were formed almost daily in Calcutta, and the shares were eagerly applied for, and rapidly rose to a high premium. The mania extended to Government officers and their subordinates, three deputy commissioners, four assistant commissioners, and several police officers, threw up their appointments to engage in tea planting, and in the subordinate grades there was such a general exodus from official employment, that business in many of the public offices was brought to a

deadlock. The inevitable reaction and collapse followed rapidly, setting in at the latter end of 1864, the climax of panic was reached in 1866, when most of the companies formed during the mania disappeared. It is a matter for profound regret that more did not share the same fate; some four or five moribund companies in London, and about twenty in Calcutta, still encumber the share lists of those stock markets; although they can never possibly return a farthing in the shape of dividend to their unfortunate shareholders, they are kept alive in the interests of agents, directors, and secretaries; their existence is an unmixed misfortune for all others connected with the enterprise, as they bring unmerited discredit and financial disrepute on the industry at large.

Notwithstanding that so many companies disappeared, leaving little or no assets, there were only one or two cases in which charges of fraudulent misrepresentation or bad faith were brought up against the promoters or vendors. The fact was, that during the mania of 1862-63, all who held grants of waste land in Assam, and had planted a few maunds of tea seed on it, honestly believed that they possessed a veritable El Dorado. They, in most instances, proved their *bonâ-fides* by declining to receive any cash payment, but stipulated for the entire consideration being made to them in shares. Although tea has the reputation of furnishing a beverage that cheers but does not inebriate, its cultivation in new districts exercises the most strangely intoxicating influences on those engaged in it, equalled only by the sanguine dreams of gold explorers. On the opening out of each new district in India, the most extravagant expectations have been formed by men who ought to have been capable of forming a reliable or dispassionate estimate. I will adduce a few instances that occurred in my experience.

I remember the late General Vetch, in 1860, urging with great force, and for the time, unanswerable arguments, that the advantages possessed by the Lower Assam districts in cheaper labour, transport, and otherwise, were so great that it could only be a question of time when tea culture would be abandoned in the districts of Upper and Central Assam. He regretted it, as being the founder of Dibrugarh, but there were the facts that one could not be blind to. Twenty-seven years have passed, and Kamroop and Mungeldye have certainly not proved more successful than the original tea districts of Assam. When I first arrived in India in 1858, I met the late Dr. Barry in Calcutta. Hearing that I was posted to a regiment in Assam, he, with the eloquent fervour for which he was noted, warned me against touching tea in the districts I was going to; he said that, as an old Assam resident, he lamented it, but he firmly believed that tea-planting in Assam proper was equivalent to throwing money into the Brahmaputra, and that before a decade all the tea there would revert to its original jungle, owing to the unquestioned superiority of the Surma districts. Cachar and Sylhet have proved very successful, but they have not quite extinguished the staple in Assam proper.

In 1873, while in Europe on furlough, I stayed at the same hotel in Paris with an old acquaintance, a distinguished general officer. He had officiated for some time as Commissioner of Assam, and more recently had exercised chief civil authority in a neighbouring district. I mentioned to him that I had heard glowing accounts of the newly opened out Darjeeling Terai, and that a yield as large as eight maunds per acre was expected from the gardens being established there. The general replied, "Eight maunds an acre! Eighteen maunds is much more certain. I say so after careful and impartial consideration of the prospects on the spot, and with some knowledge of all the Assam districts, and will be greatly disappointed if, when the Terai gardens reach full bearing, the average does not exceed eighteen maunds." The Darjeeling Terai has given very good results, but it has not, as predicted, yielded anything near an average of 1,440 lbs. per acre. If any old Assam resident desires to renew the experiences of a quarter of a century ago, the extraordinary accounts of the marvellous growth and size of tea plants, of prodigious yields, of fabulous profits, and wild visions of wealth generally, which constituted the only topic of conversation on the Brahmaputra steamers, and at the Assam stations from 1860 to 1864, he has only now to land at Colombo, stay there a week, and he may well fancy the days of his youth revived.

Since the great panic of 1865-66, the tea industry of India has made steady and generally healthy progress. It has had, of course, like all other enterprises, its periods of depression and moderate inflation, due to the fluctuations in the market value of the staple, but there has been no undue excitement upon the one hand or of panic on the other.

The actual figures of the imports into the

United Kingdom taken from the Customs returns since 1852—when the first separate records of Indian tea were kept, illustrate more forcibly than any words can do, the progress made from year to year, and the position it has at present attained—premising that the first sample reached England in 1837, in 1838 the first importation of Indian tea as an article of commerce was made and amounted to 488 lbs. It was sold by public auction in Mincing-lane, the average price realised for it being 19,5 per lb. The crop of 1839 consisted of 95 cases, and averaged 8s. From 1840 the quantities steadily but gradually increased, until 1851, when it rose to nearly a quarter million lbs. Since that year the exact figures are as follows:—

1852..	232,000	1870..	13,148,900
1853..	235,000	1871..	15,351,600
1854..	252,000	1872..	16,942,000
1855..	486,000	1873..	18,424,000
1856..	633,000	1874..	17,377,900
1857..	920,000	1875..	25,605,100
1858..	703,000	1876..	29,383,700
1859..	1,011,000	1877..	31,883,300
1860..	1,113,000	1878..	36,007,100
1861..	1,520,000	1879..	38,483,700
1862..	1,765,000	1880..	45,010,500
1863..	2,564,000	1881..	45,764,900
1864..	3,285,000	1882..	54,080,300
1865..	2,510,000	1883..	61,666,500
1866..	5,133,000	1884..	65,731,600
1867..	7,084,400	1885..	68,159,600
1868..	8,132,400	1886..	76,585,000
1869..	10,448,320		

In 1887, the crop is estimated by the Indian Tea Association of Calcutta, from returns they have been able to collect, as follows:—

	lbs.
Assam, including Cachar and Sylhet....	63,534,620
Darjeeling, Terai, and Dooars..........	14,703,300
Chittagong and Chota Nagpur	1,544,000
Dehra Dun, Kamaon, and Kangra	3,750,000
Private and native gardens (estimated)..	1,500,000
Total of Bengal Presidency....	85,031,920
,, South India*	1,000,000
Total for all India	86,031,000

But as the Association do not receive returns from every garden, these estimates are nearly always short of the actuals, last year (1886) by nearly 5,000,000. It is, therefore, safe to estimate that the actual production of Indian tea during the current season will not fall short of 90,000,000 lbs., of which about 82,000,000 lbs. are likely to be exported to this country, which I calculate from the disposal of the last three years' crops, as shown below:—

Exports of Indian Tea from Calcutta.

	1887.	1886.	1885.
	lbs.	lbs.	lbs.
Exports to Great Britain from 1st May to 31st March	75,891,757	65,797,030	61,423,583
Exports to Australia and New Zealand, from 1st May to 31st March	1,563,274	1,699,984	1,532,906
Exports to America, from 1st May to 31st March	98,616	94,599	120,573
Exports to other places, from 1st May to 31st March......	1,066,950	466,430	359,459
Total exports, from 1st May to 31st March	78,620,597	68,058,043	63,436,521

The quantity retained in India for local consumption, including the Army Commissariat requirements, and the quantity exported across the frontier to Afghanistan and Central Asia, has been returned for many years past at 1,500,000 lbs. This is manifestly incorrect, and the actual consumption of India itself must be far greater, but there is no way of ascertaining even approximately accurate figures. The 1,500,000 lbs. estimate now given has been the same for some years past, the increased European and Eurasian population alone must have caused an increase during the past lustrum, without taking into account the steadily growing taste for tea drinking among all classes of the 200,000,000 of native races in India.

The per-centage of Indian tea (in which is included Ceylon), and of China and Java, taken for home consumption in the United Kingdom, is shown in tabular form on page 740. It exhibits even more forcibly than the import statistics the steady growth in public favour of the Indian, and the rapid displacement of the Chinese staple.

A stern chase is proverbially a long one. It has taken fifty years to get on level terms with our great rival. The first quarter of the current year has seen this, while last month (April, 1887) we have actually assumed the lead, the deliveries for home consumption for the month being 13,585,000 lbs., of which India and Ceylon furnished 7,423,000 lbs., or

* The Indian Tea Association do not estimate for South India. I have obtained the figures from other reliable sources.

Per-centage of Indian and China Tea consumed in the United Kingdom.

Years.	Per-centage of Indian.	Per-centage of China.	Total.
1865	3	97	100
1866	4	96	100
1867	6	94	100
1868	7	93	100
1869	10	90	100
1870	11	89	100
1871	11	89	100
1872	13	87	100
1873	15	85	100
1874	13	87	100
1875	16	84	100
1876	17	83	100
1877	19	81	100
1878	23	77	100
1879	22	78	100
1880	28	72	100
1881	30	70	100
1882	31	69	100
1883	34	66	100
1884	37	63	100
1885	39	61	100
1886	41	59	100

51 per cent. of the whole. A truly memorable month in the history of the enterprise.

This great industry, for so it may now be designated without question, employs over 500,000 of our Indian fellow-subjects, either directly or in subsidiary enterprises dependent on it, over 12 lacs of rupees being paid to them in monthly wages. About 275,000 acres were under cultivation at the close of last year, a considerable portion of this area being immature plants; the whole, when in full bearing, it is estimated will yield 120,000,000 lbs. of tea. About £19,000,000 sterling is invested in the enterprise. The market value of the current year's crops (90,000,000 lbs.) may be roughly estimated at £4,500,000.

The great and manifold benefits which the industry has conferred upon our Indian Empire cannot be realised from mere consideration of the figures I have given, impressive even as they are. The high official responsible for the Government of Assam is most competent to gauge the advantages the province has derived from it, and in a speech made by the Officiating Chief Commissioner, at the Durbar held by him in celebration of the Queen's Jubilee, on the 16th February last, he is reported to have said:—

"I have no desire to weary you with numerous statistics, but I should like to furnish you with one or two facts and figures which will give some idea of the progress this province has made within the last half-century. For convenience of comparison I will take only the figures referred to Assam Proper, that is to say, to the five upper districts—the tea districts—of the Brahmaputra Valley. Now, fifty years ago, the population of Assam Proper was estimated not to exceed 6½ lacs; it is now close upon 18 lacs, that is to say, it has nearly trebled. Forty years ago, the settled area of Assam Proper is reported not to have exceeded 1,000,000 of acres, it is now close upon 2,500,000 acres. Fifty years ago, the first tea plantation in Assam was started, the area now under tea in Assam Proper alone is not less than 108,000 acres, and if we include Sylhet and Cachar amounts to close upon 200,000 acres. Again, fifty years ago, the ordinary land revenue which the people were found able to bear, came to about 4½ lacs. of rupees, to-day they submit cheerfully to an assessment amounting to no less than 26 lacs. If I took up the statistics of Sylhet and Cachar they would tell a similar tale of continued progress."

To properly appreciate Mr. Ward's facts and figures, I may mention that, at a public meeting held in St. James's-hall in 1883, General Hopkinson, a former Chief Commissioner of Assam, stated that so utterly hopeless were the prospects of Assam Proper for many years after we annexed it, and the Government of India were so despondent regarding its improvement, or of its ever becoming other than a drag on the finances of the empire, that when he took charge he found among the records in the Commissioner's office, a suggestion from the Supreme Government, that the province should be made over to a joint stock company, or some association of adventurers, if any such could be found willing to undertake the responsibilites of its administration.

The statistics of imports and per-centages of consumption of Indian and China teas, which I have already submitted to you, shows the steadily progressive strides which the former has made annually—almost without interruption—towards furnishing the entire supply required for the United Kingdom; but it must not be supposed that this success has been attained without great sacrifices on the part of both countries, of India, in order to oust her rival, and of China, to hold her monopoly, or to maintain her supremacy. The consequence has been an extraordinary fall in the value of tea amounting in ten years to about 46 per cent., a circumstance which was noticed by the Chancellor of the Exchequer in his recent budget speech. Mr. Goschen observed that if the duty of sixpence per pound had been remitted a few years ago, in defer-

ence to the cry for a free breakfast-table, the consumer would then have to pay actually more for the duty-paid articles than he does now with the duty retained. Whether the producer in China has had to bear the whole of this shrinkage in value, without any compensating reduction in the cost of production is unknown, as the conditions under which the staple is raised in China is very much a matter of conjecture—at least no exact or reliable figures can be ascertained, as in the case of our public companies with their audited accounts. An analysis of the accounts of the ten principal tea companies who have their registered offices in London, gives the following most interesting figures :—

Analysis of the Working of Ten London Tea Companies.

Year.	Cost of laying down in London, including sale charges per lb.	Prices realised per lb.	Profit per lb.
	s. d.	s. d.	d.
1878.........	1 5	1 9¼	4¼
1879	1 4¼	1 7½	3¼
1880.........	1 1¼	1 3¾	2½
1881.........	1 0½	1 6	5½
1882....... .	1 0	1 3¼	5¼
1883.........	1 0	1 2¾	2¼
1884.........	0 11½	1 2¼	2¾
1885.........	0 11	1 2¼	3¼
1886.........	0 9½	1 0	2½

These figures explain the situation, and reveal at a glance why China has been worsted in the struggle, and why India has displaced her. The former country, working under conditions centuries old, and with an exhausted soil, has been unable to materially reduce cost of production, and has endeavoured to meet the demand for cheaper teas, to compete with her vigorous young rival, by supplying year by year an increasingly inferior article until her produce is now thoroughly discredited, while India has met the annual fall by a corresponding reduction in cost.

If we take any year of the nine that the figures embrace, we find that there has been always some profit left to the Indian planter, and that the result of the nine years' operations is a fall in value of 9¼d. per lb., and a diminution in outlay of 7½d. per lb The average profit for the nine years has been 3¾d. per lb. In all well-managed concerns not overloaded with capital, each penny per pound profit should represent 3 per cent., and the dividend of the companies referred to has just averaged 9 per cent. for the period.

I will now proceed to consider the means by which this reduction in working expenses has been effected by the Indian planters, and how far still further reductions are possible.

The principal factor in producing the reduction has been the depreciation of silver, and consequent fall in all Eastern exchanges, and accounts for 2½d. per lb. As all the tea of the world is grown in countries having silver currencies, the Indian tea industry derives no special advantage from the low rate of exchange, further than so far as cheaper prices may stimulate the consumption of an increased quantity of tea, but otherwise the silver question does not affect the Indian planter. If his monthly remittance of, say, £500 sovereigns exchange into more rupees than heretofore with which to pay the labourers on his estate, so likewise the China merchant's remittances of gold from this country to buy tea at Shangai or Fowchow produces a corresponding larger number of dollars. If exchange again rose to 2s. for one rupee, it would only concern Indian planters in so far as it would enhance the price of tea from all countries to the extent of 3d. per lb., and thus diminish the purchasing capabilities of the working classes in this country.

The economies effected in Indian and home expenditure amount, as I have shown, to about fivepence per lb. since 1878, and may be classed under the headings of labour, packing, transport, Calcutta charges, stores, sale charges, and administration.

As labour, including European supervision, amounts to about three-fourths of the entire expenditure, it was under this head the chief economy was possible, and has been carried out, not by reduction of wages, for both managers and coolies earn more than they did ten years ago, but by getting better work from all. Each European now superintends the production of twice or three times the quantity that was customary a few years ago. It was not usual to find then a manager drawing 400 rupees monthly, and an assistant 150 rupees, employed on a garden turning out not more than 1,000 maunds or chests; the cost of European supervision was therefore 6 rupees 8 annas per chest of 80 lbs. At the present time, owing to extensions or amalgamations with other gardens, two Europeans,

the manager receiving 500 rupees, and the assistant 200 rupees, are considered sufficient for a concern turning out 3,000 chests annually; the cost of supervision is thereby reduced to 2 rupees 13 annas per chest, a saving of about one penny per pound. No further economy is likely to be effected in this item, except in those instances where two Europeans are employed on a smaller out-turn than 3,000 chests. The obvious remedy is to extend the cultivated area, so as to produce 3,000 chests, or to absorb some neighbouring gardens.

The coolies in Upper Assam, beyond doubt, do more work now than heretofore; the tasks for hoeing and plucking have in ten years increased by one-fifth, notwithstanding that the average earnings of each labourer is far larger, as shown by the Government inspection returns, This is due to the fact that the immigrant labourer is now happier and more contented than was the case a decade ago; he works with a better will, is less despondent and nostalgic, and looks forward to acquiring land and settling down in his new country on the expiration of his indentures, instead of returning to the poverty and periodic famines of his native district. The vicious system of giving large sums by way of bonus to coolies on renewal of their agreements has been modified, and its entire abolition is only a question of time.

The cost of importing labourers from Chota Nagpur and other districts of Bengal to Assam is still very heavy, but the influences which I have just adverted to in ameliorating the condition of the coolie immigrant will before long effect a revolution in this respect. With improved communications—and a railway through the valley cannot much longer be denied to Assam—a steady flow of free or at the outset aided emigration must set in from the congested districts of Bengal and Behar to the highly remunerated labour markets of Upper Assam. This has happened in Cachar, Sylhet, and the Dooars, where the difficulties and expenses attendant upon the importation of labourers, was at one time nearly as great as in Assam Proper.

Labour and fuel-saving machinery and appliances have effected the greatest economy in Assam Proper, where scarcity of labour has always been the chief if not the only difficulty, but have also done much to reduce the cost of production in all the Indian tea districts. The admirable drying machinery of Messrs. Gibbs and Barry, Davidson, and Jackson, have not only reduced the number of hands required in each factory, but have effected an immense saving in the quantity of fuel required in the processes of manufacture. As improvements are annually recorded in all descriptions of tea machinery, whether for rolling, drying, or sorting, it would be difficult to estimate how much lessened expenditure may be looked for in the future under this head.

Packing costs less than one half what it did some years ago; chests imported from Burmah or Calcutta at from 1 rupee 12 annas to 2 rupees 4 annas each, are now procurable on the spot at from 12 annas to 1 rupee, and the sheet lead for lining them has gradually dropped from £38 to £16 per ton. Transport is not only much cheaper but is far more expeditious. The freight rates of the river steamers have come down more than 33 per cent. in ten years; they are still, however, the highest rates for water-borne goods in the world. Negotiations are now going on, the outcome of which must be a further reduction of fully 33 per cent., whether the services be conducted by the existing steamer companies, or by a new line started with the support of the tea industry. Ocean freights have fallen from 70s. to 38s. 6d. per ton. At the latter rate a contract has just been entered into by the principal concerns for a fixed rate of freight for three years from Calcutta to London. It is not only the reduction in rate, but numerous concurrent advantages, all contributing to saving of expenditure, will be secured by having teas carried in a special line.

The railways from Diburgarh to Sadiya, from Kokila Mukh to Jorehaut, and from Sara to Darjeeling, have not only greatly reduced the cost of transport in the tea districts served by these lines, but have also, in many ways, tended to cheapen production. When the projected Chittagong-Assam Railway is constructed the important districts of Sylhet and Cachar will derive great advantages, all contributing to reduction of expenditure.

Stores obtained from Europe, in which is included machinery, implements, &c., has fallen over 40 per cent. in ten years, in sympathy with the general drop in the value of iron, and although we cannot expect much further depreciation in iron, the cost of tea machinery is still absurdly high, and must come down when the patents expire under which the present appliances are protected.

Calcutta charges have steadily decreased year by year as the out-turn has increased, for there is very little additional agency duties involved in the working of a concern of 10,000

chests out-turn than in one of 1,000, and as estates have grown by extension or fusion, agents have, in most cases accepted rateably lower remuneration. There is, however, still much room for reduction. The management, control, and responsibilities which were exercised by Calcutta agents in former days were then very properly highly remunerated by salaries or commissions fixed on a very liberal scale. But the condition of things under which the administrative management by Calcutta agents originated is either now a matter of history or is rapidly becoming so. Tea estates are now, as a general rule, under the management of gentlemen of high character, business capacity, and many years' experience of their profession, and it is far wiser for principals to throw the undivided responsibilities upon such men without any intervention or supervision on the part of agents, a system which is altogether wrong in principle, and has worked most disastrously in many instances. In nearly all the most prosperous and best managed estates the duties of the Calcutta agents are now confined to landing and shipping goods and the execution of petty indents. The usual charge of 8 annas per chest for transshipping tea from the river to the ocean steamer will in future be an unnecessary tribute to the Calcutta cargo boat owners. It was necessary hitherto, when the tea on arrival had to be distributed among eight or ten different lines of steam vessels; but in future, when the great bulk of the cargoes of the Brahmaputra and Surma steamers will be for the Planters' Line, the river vessel will of course go alongside the ocean ship, and transfer her cargo without the intervention of lighters.

When a social or economic change involves loss to any particular body, it is not always accompanied by compensatory advantages; but in the case of the Calcutta merchants, whatever they may lose in their capacity of agents, they will more than recoup by the larger profits derived from their properties, as a large proportion of all tea property, whether in private estates or in stock of public companies, is still held by members of Calcutta firms. Under the head of sale charges is included warehousing and brokers' commissions, and the term warehousing comprises landing the tea from the ocean ships, housing, weighing, preparing for inspection prior to sale, repacking and finally delivering to purchasers. These are the only charges in connection with the industry which until last year did not mark progressive decline. The nominal fixed charge is 5s. for a chest of 80 lbs., from which varying rates of discount have been allowed; a few years ago it was as much as 60 per cent., and last year was 15 per cent., which is 20 per cent. more than ten years ago. In 1884-85, some warehouse proprietors, acting under the belief that the tea industry was without any efficient protective organisation, formed themselves into what our American cousins call a ring, but to what the law of this land applies the unpleasant term conspiracy. This ring, by a *coup d'état*, in one swoop disallowed all discount whatever, thus enhancing the net charges by 60 per cent.

Conspiracies to plunder and boycott may succeed for a time in London as in less civilised countries, but retribution comes inevitably. In 1886, the Indian Tea Districts Association arranged to support a new warehouse (Butler's Wharf) who agreed to do the work for fair remuneration, and last season about 40 per cent. of the entire imports went there. The action of the Association has shattered the ring, the late bandits are now at one another's throats, offering lower and lower rates weekly, and have now reached a point so low, that it is impossible one half of them can outlive the struggle.

The selling brokers' commission has remained the same for ten years; considering the services rendered, it is an exceedingly moderate rate of remuneration, and is not likely to alter. Administration is the item of expenditure in which relatively the greatest economies have been made, and in which there is still ample room for further reduction. This end can be best attained by amalgamation of adjoining concerns, as the office machinery for conducting the affairs of a company with an outturn of 30,000 chests should not be very much more than is needed by a concern of 3,000. The 90 odd miniature companies having their head-quarters in Calcutta might, with great advantage to their shareholders, be fused into 8 or 10—one representing each district—if the claims of agents, managers, and others could be overcome. The movement has, despite these interested opponents, set in, and during the past three years many fusions have taken place, to the manifest advantage of the proprietors.

I have now endeavoured to show how the great reduction in outlay of 7½d. per lb. in ten years has been brought about, and I believe that these factors are still tending towards the same end, but more rapidly than in the past, and I look forward with confidence to further

reductions of one penny per pound annually for the next three years, and I venture to predict that if no disturbing cause—not at present foreseen—occurs, the crop of Indian tea of 1890 will be placed upon the London market for a fraction under 6d. per lb.

But this result can only be achieved by the directing minds of the industry strictly observing the principles and policy which have insured for them such a large measure of success of late years. This success must not permit them to falter in pursuing further economies; to do so effectually they must steel their hearts against mere sentimental feelings. Live and let live is a touching proverb, but I find that it is generally enunciated by those who want you to pay them more for some article than you can get it for elsewhere. We have all seen how races have been lost by over-confidence. We have now caught up and passed our great rival at the half-way post. To win the great prize—the entire tea supply of the United Kingdom—we must follow the same economical tactics unflinchingly.

Before I close this paper, I will very briefly discuss the possibility of an over-production of tea in all countries, with the probability of the disastrous consequences happening to the Indian grower, which, in the instances of the over-production of wheat and sugar, has overtaken the English farmer and the West Indian planter. The consumption of tea of all sorts in the United Kingdom in quinquennial dates since 1870 has been in lbs.:—1870, 117,000,000; 1875, 145,000,000; 1880, 159,000,000; 1885, 187,000,000, showing an average annual increase of four and two-third millions. It is true that this ratio of increase has not been maintained for the last three years, but the explanation given by the Chancellor of the Exchequer is undoubtedly the correct one—*i.e.*, that the consumption of infused tea has gone on increasing at probably a greater ratio than heretofore, and that the far greater strength of Indian tea has furnished a much larger number of cups of the beverage from the same quantity of leaf used. The annual displacement of China tea for the past three years is shown in the amount taken for home consumption in lbs., this year being for eleven months only:—1885, 116,000,000; 1886, 100,000,000; 1887, 89,000,000. Assuming that the deliveries of China tea for this month (May) will equal that of last month, this would bring the total consumption for last year to 96,000,000 lbs., in round numbers, showing an average displacement of China tea by about 7,000,000 lbs. annually, thus providing with the increased consumption an outlet for an increase of Indian and Ceylon tea of about 12,000,000 lbs. annually, which might take place without any further disturbance in values, but for the next few years the increased production of India and Ceylon will not be less than 15,000,000 annually, so that China must give way in future at a still more rapid pace than hitherto, and this can only be brought about by a still further fall in the values of teas from all countries, and I have attempted to demonstrate how the greatest probable fall can be met by the Indian planter without any diminution of profit.

The command of the tea supply not only of the United Kingdom but of the world, will

Indian Tea Companies' Dividends.

Statement showing the Actual Amount of Dividends distributed by 24 *of the principal Indian Tea Companies, in respect of* 1885 *crop*:—

	Capital paid up.	Amount of Dividend distributed.	Rate per cent.
	£	£	
Assam	187,160	37,432	20
Brahmapootra	114,500	18,320	16
Borokai	43,560	6,970	16
Jorehaut	100,000	15,000	15
Doom Dooma	116,100	15,383	13¼
Mookhamcherra	47,500	6,175	13
Jokai	56,037	5,604	10
Jhanzie	55,000	5,355	10
Tiphook	26,000	2,600	10
Panitola	58,810	5,881	10
Chargola	65,500	6,550	10
Lebong	82,070	7,386	9
Darjeeling	135,420	10,834	8
Dooars	106,000	749*	8
Hingajea	36,000	2,880	8
Borelli	78,170	4,690	6
Indian (of Cachar)	94,060	5,644	6
Dejoo	43,580	2,615	6
Scottish Assam	79,590	3,980	5
Moabund	35,007	1,750	5
Balijan	31,000	1,395	4½
Nassau	36,000	1,440	4
Luckimpore	76,852	3,074	4
British Indian	243,300	3,041	1¼
	1,947,300	174,748	

Average dividend 9 per cent.

* Working part of year.

Compiled by Ernest Tye, Secretary, Indian Tea Districts Association, October, 1886.

Annual Average Consumption of Tea in English Pounds.

	During Five preceding Years.		Per Head of Population.	During 1885.		Approximate Duty in Pence, per English pound.
Australian Colonies......		18,200,000	7·66		21,474,395	Mostly 3d., in some parts, 4d. to 6d.
New Zealand		3,902,000	7·23		4,442,867	4d.
Tasmania	about	699,500	5·35		871,205	3d.
Great Britain		170,733,600	4·70	(1886)	178,891,000	6d.
Newfoundland		824,000	4·38		795,917	3d. + 10 per cent. *ad. val.*
Straits Settlements ...	(1884) about	2,098,320	3·88		2,363,820	Free.
Canada.........................		16,600,000	3·69		18,255,368	10 p.c. from U.S.A., others free.
Bermuda	(1884)	51,558	3·45		43,563	5 per cent. *ad val.*
United States	(1883-4)	70,572,530	1·40		72,835,082	Free.
Holland		4,860,373	1·16		4,785,355	2¼d.
Cape Colony		1,128,500	0·90		1,140,260	8d.
Natal		327,300	0·76		426,983	7d.
Russia		62,408,500	0·61		59,184,000	2d. to 11½d. 1/10½ from European Frontier.
Denmark	(1880-3)	746,000	0·37	(1884)	685,113	3d.
Uruguay	(1884)	176,930	0·34	(No returns)		5½d.
Argentine Republic	(1883-4)	900,000	0·30		647,275	6½d.
B. Honduras		7,250	0·26		12,313	6¼d.
Barbadoes		35,970	0·21		35,961	3d.
Trinidad		27,215	0·16		30,629	6d.
Antigua		5,649	0·16		6,785	4d. + 12 per cent.
British Guiana		40,333	0·15		31,170	6d.
Persia	(1884) about	1,043,000	0·13		1,120,000	Not stated.
Portugal		561,000	0·12		565,495	1/7½.
Bahamas		4,852	0·11		4,493	1/-
Switzerland	(1880-2)	292,000	0·10		253,814	1¾d.
Norway........................		170,400	0·09		169,160	9¼d.
Germany		3,113,500	0·07		3,950,221	5½d.
Grenada		3,189	0·07		2,700	6d.
Morocco	about	354,000	0·06		693,750	10 per cent. *ad val.*
St. Vincent		2,498	0·05		3,168	6d.
Jamaica		22,002	0·03		23,077	1/-
Belgium	(1883-4)	155,896	0·03		127,781	3¾d.
Sweden	(1880-3)	139,250	0·03	(1884)	155,232	4¾d.
France	(1882)	1,029,561	0·03	(1884)	1,172,355	9d. to 11½d.
Roumania	(1881-4)	133,839	0·02	(No returns.)		2½d.
Austria Hungary	(1883-4)	739,500	0·02		958,414	8¼d. to 9d.
Bulgaria	(1884)	33,699	0·02		42,184	8 per cent. *ad val.*
Spain	(1884)	136,000	0·01		287,509	10d. to 1/1½.
Paraguay	(1884)	7,646	...	(No returns.)		Not stated.
Costa Rica		...	...	about	3,000	4¾d. on gross weight.
Turkey	(No returns.)		...	(No returns)		8 per cent. *ad val.*
Italy	Nominal.		...	Nominal.		8¾d.
Greece	Nominal.		...	Nominal.		About 1/6.

The quantities taken by the majority of the largest tea-drinking countries show a decided increase; a number of the minor consumers have also imported more tea. Our principal Colonies show very satisfactory increases, especially Australia and Canada. The figures for the United States are also encouraging. There is reason to believe that tea consumption in France is likely to increase. Duties.—The rates of duty in some European countries certainly appear prohibitive. In most of our Colonies only light duties are imposed. In the United States, and practically in Canada, the article is admitted free, and thus our attention is again drawn to the markets of North America as extensive fields for future enterprise.—Gow, Wilson, & Stanton, Tea Brokers, 13, Rood-lane, London, E.C.

INDIAN TEA.—IMPORT IN 1,000 LBS., MONTHLY, FROM 1877 TO 1886, WITH AVERAGE PRICE REALISED.

	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
January	2,156	5,579	4,182	5,470	5,244	7,212	7,510	9 081	7,650	10,620
February	2,150	2,827	3,2,1	3,899	4,564	3,113	6,741	5,834	4,959	4,890
March	2,801	3,127	3,677	3,969	4,753	6,620	4,310	5,510	4, 92	6,494
April	1,757	1,899	2,540	1,553	1,503	2,557	2,579	2,783	2,184	1,802
May	812	895	708	723	332	584	1,630	932	596	125
June	817	978	597	254	423	861	561	462	599	618
July	1,617	1,838	886	1,396	1,214	1,875	1,688	1,552	2,599	1,826
August	2,571	2,410	2,066	2,966	2,067	2,492	4.357	3,866	3,854	4,392
September	3,285	2,876	5,025	6,502	5,025	7,497	6,828	7,242	7,849	9,163
October	6,581	3,941	5,253	6,089	5,146	6,406	9,163	10,647	11,428	11,183
November	3,912	3,871	5,048	5,252	7,975	9,156	9,039	8,806	7,724	11,360
December	3,425	5,768	5,259	5,936	5,181	5,705	7,261	10,438	9,228	76,587
	31,884	36,009	38,482	44,009	43,527	54,079	61,667	67,153	63,162	76,587
Average......	1s. 9½d.	1s. 9¼d	1s. 7½d.	1s. 3¾d.	1s. 6d.	1s. 3¼d.	1s. 2¾d.	1s. 2¼d.	1s. 2¼d.	1s od.

Compiled by W. Jas. & Hy. Thompson, 38, Mincing-lane.

finally rest with whatever country can produce it at least cost, a law that applies to all commodities. The conditions essential for cheap production are (*a*) abundant labour; (*b*) cheap food; (*c*) cheap fuel for manufacturing processes, and soil and climate capable of producing large yields from a given area. In all these respects the position of the Indian tea industry is absolutely unassailable. India, with a population of over 250,000,000 inhabitants, furnishes the cheapest labour in the universe; grain and all other food used by Asiatics is at least 50 per cent. cheaper than in any other tea country; there are inexhaustible supplies of cheap wood and coal at the factory doors; the soil is a bed of rich alluvium, needing no manurial restoratives; the rainfall and temperature are most suitable to the plant, as proved by its indigenous growth; the yield in Upper Assam and Durrung, on the flat lands of Cachar and Sylhet, in the Darjeeling Terai, and in the Dooars, is from 500 to 800 lbs. per acre. If, with all these advantages, increased production leads to a real struggle for existence, and if the industry in any particular district succumbs, we, who have watched its growth and development for many years past, will, at all events, have the satisfaction of knowing that it has in such districts been overcome not by foreign rivals, but by more favoured districts of the same Peninsula.

I will not trouble you with any further figures or details. Above are given some interesting Tables, for the compilation of which I am indebted to Messrs. Wm. James and H. Thompson, the leading brokers of Mincing-lane, and also to Messrs. Gow, Wilson, and Stanton, to whose industry and enterprise in the preparation of periodical diagrams and tables the tea industry both of India and Ceylon are under weighty obligations.

DISCUSSION.

Mr. HAYNES said he could corroborate the statements made as to the wonderful improvement in the manufacture of Indian tea. In 1876, a friend of his, who was much affected with the mania which had been spoken of, wrote to him saying that the cultivation reached to about 240 lbs. an acre, and he saw it had now reached as much as 800 lbs. In the same letter he gave a singular description of the manufacture of tea, which showed how much it had improved since then. He said the leaves were collected in a large room, 200 feet long, where the tea was manufactured and soldered up in boxes. The process of manufacture was very simple. The young leaves were plucked and brought in by women, weighed, and then taken to tables, where 10 or

15 strong men worked it up much as a housewife would dough, and it then began to sweat or ferment. Each man rolled his lump of tea about the size of a loaf, when it was left on a mat for from two to four hours to ferment, and on this process depended the whole art of manufacture. The loaves were then tapped and scattered over mats in the sun; in two hours time the leaves turned from green to black; they were then turned on sieves three feet from charcoal fires, and afterwards sorted and picked. Since then, by the aid of machinery, no doubt, great improvement had been made.

Mr. SHILLINGTON said Mr. White had placed all those who were interested in Indian tea under a deep obligation. The mass of figures he had collected was astonishing, and would be extremely useful in days to come. He remembered being present in that room about ten years ago, when a paper was read on Indian tea, in which a great complaint was made against the tea trade generally, to the effect that tea dealers stifled the demand for Indian tea, and tried to foist off China tea instead. He was pleased to find that Mr. White adopted a much more hopeful tone on that point. At that time he ventured to prophecy that as soon as India could supply enough tea to meet the entire wants of the United Kingdom, so soon would the demand rise to that point; and Mr. White's figures bore out that prediction. The consumption then was 36,000,000 lbs., or about 17 per cent. of the total. It was now 75,000,000 lbs., or 41 per cent., and very likely in some years China tea would be driven out of the market. Mr. White appeared to have assumed that China tea was the only competitor with Indian, merely giving a passing allusion to Ceylon, but he thought Indian planters would make a great mistake if they did not look out for Ceylon as a very strong competitor in the near future. There would be 86,000,000 lbs. of Indian tea in the coming season, and probably not less than 15,000,000 lbs. to 20,000,000 lbs. from Ceylon. As a tea taster, in daily work in Mincing-lane, he would say that if anything like 100,000,000 lbs. per annum were sent from India, the breaks must be larger than they now were, or they could not cope with the number of samples. The average size of a break of Indian tea, five years ago, was twenty-six chests, and a few months ago he had the figures taken out, and found it was only twenty-nine chests, showing a slight improvement, but not very much. In China tea, which was the great competitor, he had found that the average size of the breaks was 184 half chests, or 92 chests, and the China buyers said they had quite as much as they could do to get through the tasting with 90 chests in a lot. It was quite evident, therefore, that if the supply from India was to be 100,000,000 lbs., or probably in the next ten years 150,000,000 lbs., the work could not be got through if the breaks were still kept to about thirty chests each.

Dr. PRINGLE said very early in his service in India he was introduced to tea at Kumaon, in the Himalayas, and had since seen it steadily progressing in the Dehra Dun. Mr. White came from Assam, and thus they had had a good view of that side of the picture, and the poor Dehra Dun had been left in the jungle, although he was glad to say that the tea cultivation there had very much improved. It would yearly become more difficult to calculate accurately the amount of tea cultivated in India, owing to the large number of private tea gardens worked by natives, just as it was very difficult to find the true output of indigo from the natives manufacturing it and selling it privately amongst themselves. The Chinamen who were first employed in the Dehra Dun were real honest tea-men; but there was one thing which threw the whole cultivation back for a considerable time, and that was the ignorance as regards the scientific cultivation of the plant. It was reserved for two Scotch gardeners to sit down by a tea bush and study it, and since then a great improvement has taken place. The tea cultivation in Assam was one thing, and in the Dehra Dun and other places in the North-West Provinces and Punjaub it was very different, not only as regards the pruning, planting, and digging, but everything apparently seemed to be very different, though all might be summed up in the quality of the soil, that in Assam being pure, deep, virgin soil, which that in Dehra Dun most certainly was not; but the real failure in the early days of the industry was, he believed, owing to the companies being crushed by the enormous amount of capital, which prevented any profits being given to the shareholders. But now the tea industry in the Dehra Dun, and in many parts of Kumaon, was advancing owing to the results of careful study, though he feared it would have a difficulty in competing with Assam. He should like to know what was the cost of transport of tea by railway in India, and whether any allowance was made for it as it was for wheat. He was glad to say that tea drinking amongst the natives was fairly established; they regarded it as one of their luxuries, and the cheaper it could be made the more extensively would it be used, until at last a very large quantity would be required for native consumption. The buying of tea went down to a very low scale of daily wage, especially in countries where there was malarial fever. It seemed to have a wonderful power of invigorating, and natives recovering from fever enjoyed it very much. Ere long he hoped the natives would find the tea made in their own country superior to anything; as it was, the tea from China seldom came further north than Calcutta. He would also like to know if the secret of the peculiar flavour of Darjeeling tea had been discovered; was it a different plant or was it due to the mode of cultivation, soil, or elevation? At one time the Kausani tea was thought to resemble Darjeeling, and held a good place in the market. He did not think there was any fear of over-production of tea, and often regretted that when he went

to a public bar to get a cup of tea or coffee, he had to pay twice as much as those who wanted a glass of beer or porter. Tea would never take its proper place in the public demand until this state of things was altered.

Mr. MARTIN WOOD was glad to have an opportunity of calling attention to the inestimable value of the Indian Medical Service, especially under its old fashioned constitution; Dr. Campbell was the pioneer of Darjeeling, and, in a great measure, of tea also. He remembered Lord Napier speaking of his experience when he penetrated with Dr. Campbell to Darjeeling, which was then almost inaccessible; but the progress made since that time was very remarkable, and throughout, medical officers had been pioneers in the enterprise. He was glad Mr. White had not forgotten the martyrs of the tea enterprise, some of whom he had known, and now the country had entered into their labours with the grand results which had been depicted in this paper. Very seldom did a new enterprise grow so rapidly as this had done, especially in later years, since the early mistakes had been overcome. One of the most important points was that it had promoted migration, one of the great needs of the Indian population; because of the congestion in some districts, and a great aversion to removal from one part to another. The tea industry had been one means of overcoming that, although there were some difficulties at first, and some conflict between those interested and the Government. He was glad to say that the Government maintained its principle of defending its weaker subjects all through, but those difficulties had now been overcome, and he gathered that this migration might now be considered to be a normal condition of things. Mr. White had also done justice to the early and courageous efforts of the Government in promoting this industry; and that reminded them that, in India at any rate, there could be no dispute that it was the province of the State to do what it fairly could to foster a rising industry. He had been reminded of this lately by a letter from Mr. Wardle, in which he spoke of the efforts now being made to revive sericiculture in Bengal. In that industry also Government was giving direction and stimulus, and the same principle might be applied judiciously in other directions. Another important matter was that of transport. Mr. White had referred incidentally only to the Kangra Valley tea, and the Dehra Dun was in the same category, the export was very small in proportion to that from other parts, but that was owing to the excessive cost of land carriage. Some years ago, when investigating the shrinking value of the rupee, he found that the cost at Bombay from the spot where the Kangra Valley tea was put on the railway was $2\frac{1}{4}$d. per lb. Reference had been made to the probability of obtaining a lower rate of carriage on the river steamers from Assam as depending on some negotiations which were taking place, but he thought that reduction could only be very small. Another means of reducing the cost of transport would be that referred to by Mr. Bradford Leslie, the great engineer, when he pointed out, although chief engineer of the Eastern Bengal Railway, that a canal would reduce the cost of carriage and equalise it enormously; and he thought if a somewhat bolder view were taken of transport in that direction a greater effect would be produced than in any other way. With regard to the question of the figures given as to the capital invested, £19,000,000, and the returns, £4,500,000, this was interesting, and showed how productive was the investment of capital in India under favourable circumstances; and that should be an encouragement in other directions besides tea and coffee. Of course, there were difficulties to be got over, but by taking advantage of experience it was evident that the profit from judicious investment of capital in India would be very great.

Mr. HYDE CLARKE said those interested in India, and in the tea industry, could not be too grateful to those who had brought it to its present condition, amongst whom was a distinguished man referred to in the paper, Sir Charles Trevelyan. It was, however, to Dr. Archibald Campbell that they owed most of all. After his return from India he devoted himself to the promotion of the tea industry, and to the formation of a tea committee for the general protection of their interests. He also induced that Society to give prizes for promoting the improvement of the cultivation, and his name would always be remembered there. Another friend of India was General Hopkinson. They were particularly indebted to Mr. White for giving a statistical paper in which figures were dealt with not as they often were, without any real reference to their meaning. They had had that evening an illustration of the principles which had resulted from those figures, and it was impossible for anybody who would read the paper not to derive much instruction from it. No economist could read it without being struck with the results which he had brought forward. With reference to the silver controversy, he would remark that not long ago there was a similar paper on coffee read in that room, when it was stated that the reduction in silver had not affected coffee planters in India, and it was also shown that this was the case with regard to the production of tea. Of course there were other investments in which the alteration of the rate of silver produced a very great effect, but this was a subject too wide to be discussed then. With regard to the consumption of tea in this country, there could be no doubt that the greater extent of cultivation of Indian tea had produced a more effective consumption than the mere weights would imply. What they really had to get at was not the amount of importation through the Customs, but the amount of consumption by the public, and it was more than possible that, as the

public got to appreciate Indian tea, as they were now doing, for you constantly saw Indian tea marked up in the shops, they would get real Indian tea instead of the grocers' Indian mixture. When the public got to appreciate the individual qualities of Indian tea as they used to do the Chinese, it might lead to a considerably more effective consumption of tea instead of the mixtures, which did not always include solely Indian tea, or China tea, but which were still supposed to embrace some of the traditional substances which grocers thought did as well, although their customers did not.

Mr. DIPNALL thought sufficient allusion had not been made to the effect of the opening of the Suez Canal in giving facilities for the importation of tea and other commodities from the East. When one heard that the production of tea had been raised from a very small amount to 800 lbs. per acre, and that these virgin soils had apparently no need of manure, he could not help fearing that this continual increase in production would lead to a deterioration in quality, especially as there was a constant tendency to cheapen the article. If you could get tea at 6d. a pound, and a continuous production of 800 lbs. an acre without any manure, he could only say it was a kind of cultivation with which he was absolutely unacquainted. Every farmer knew that he could not double and treble his crops without increasing his manure and deepening his ploughing, and therefore he thought they must somewhat moderate their expectations of the enormous extension of tea cultivation at a profit, desirable as it was in the interests of the temperance movement, because this movement would be much checked if the public began to receive an inferior article. Every one must rejoice at the enlargement of the importation from India, and the rate at which it had overtaken that from China. The greater proximity to this country and facilities of transport were great advantages, but he should like some explanation of how this increased production was to continue without the use of manures.

Mr. HUGHES asked if Mr. White could say whether manure had been at all used in the Indian tea cultivation. As had just been remarked, to go on producing tea year after year from the same soil could not be attended with very good results, either as regards quantity or quality. Mr. White himself had mentioned the falling off of China tea, as probably due to exhaustion of the soil, and he supposed it was only a question of time with Indian tea, unless the crops were supported by the application of manure. In 1877-8, he was engaged by the Planters' Association of Ceylon to visit the principal coffee and tea districts, and he could cordially support the remarks of Mr. Shillington as to Ceylon becoming a very formidable competitor in the matter of tea. The flavour of the Ceylon tea was very good, and the character of the soil, so far as his examination went, led him to believe that it would probably continue to produce this highly flavoured tea. It was not a very rich soil, but the climate, the amount of moisture, the conditions of labour and transport were so favourable, that it might be looked to as a large producer of tea in future. According to his analysis, there were in 1,000 lbs. of tea 45 lbs. of nitrogen, a much larger quantity than would be found in a crop of wheat; and they knew that they could not in this country go on producing wheat for long periods, even in very superior soils, without a falling off in quantity. The Americans would find that out in time, and there would be a repetition of what the Chinese had found with regard to tea.

Surgeon - General DE RENZY said the previous speakers were probably not aware of the nature of the soil in Upper Assam. It was a very rich alluvial soil, without a pebble in it, to a depth of some 30 feet. His impression at one time was that notwithstanding the great natural richness of the soil, its fertility might be increased by the addition of manure containing nitrogen and phosphates, and at his suggestion one of the companies made considerable experiments with manures of that character, but it was found that these artificial manures had no appreciable effect. He was convinced, therefore, that in Upper Assam there was no need for the application of manures.

Mr. BERRY WHITE said he was very glad that Mr. Haynes had stated the former mode of manufacture, and hoped it would become widely known, because that was the dirty way in which all China tea was still made, whereas in Assam it was made by machinery, and was never touched by hand at all. He was very glad to meet Mr. Shillington, having known him by name for a long time, and being aware of the intelligent interest he had taken in everything affecting Indian tea. The tea industry was indebted to him for many valuable hints. At one time no doubt, when the industry was in its infancy, there was some jealousy of the great dealers in Mincing-lane, but now it was in mature manhood, and did not want dealers anywhere to show it any preference except such as was due to the superiority of the articles supplied. He had a very high opinion of Ceylon tea, but Ceylon and India ran on parallel lines, and had no need to be jealous of one another. If it came to a question of relative cost he had no fear of Assam. The paper, however, was especially on Indian tea, and he had not, therefore, gone into the question of Ceylon tea at any length. Though he had said nothing directly about larger breaks, the whole tendency of the paper was in that direction, as he had pointed out the desirability of amalgamating adjoining gardens. Of course large dealers would taste and examine breaks of 100 chests when they would not look at 30. Dr. Pringle seemed to think he had put forward Assam

too much as against the North-West Provinces; he was dealing with the whole of India, but he could not overlook facts and figures in taking a dispassionate view of the industry. He had returns from three or four estates which showed that in the North-West Provinces tea cost 1s. 3d. per lb., and it was sold in London on an average at 10d. On the Northern and Eastern Bengal system, the cost of transport was very moderate indeed, and on the Indus valley system by which the Kangra Valley tea was sent to Currachee. The late Sir Douglas Forsyth told him he had made favourable arrangements for its transport. The cause of the peculiar flavour of Darjeeling tea was one of the secrets of nature which had not yet been discovered. You could not tell why a vineyard on a particular slope produced a remarkably flavoured wine, but so it was. With regard to the kind remarks which had been made of the Indian Medical Service, he thought they had started nearly everything in India; telegraphs, the post-office, the jail system, forestry, and the educational system, all had been initiated by medical officers. Mr. Martin Wood had made some very thoughtful observations about migration from the congested districts, and this was a very large subject which would come very prominently before the Government of India ere long. As vaccination, sanitary science, and other things progressed, the former checks to population had been removed, and in a little time the population of Bengal and Behar would not have standing room. At the same time in the fertile valley of the Bramaputra, and in some parts of the Luckimpore district, the population was only ten to the square mile, and it was there the great future of India would be. The sooner these districts were opened up by railway communication, the sooner would the possibility of famine in Bengal and Behar be removed. With regard to the negotiations for a reduction of transport, the same consideration applied to all commerce. You would burn the candle at both ends if you did not save a shilling here and seven-and-sixpence there when you could. It was necessary to save even 1-32nd of a penny when you could, and all these little savings mounted up until they made one penny a pound, or 3 per cent. on your capital. He was very familiar with Mr. Leslie's plan for making a canal through the Sunderbunds, and it would have been an admirable scheme for Eastern Bengal, though he did not know that it would have done much for Assam; but the railway interest prevailed, and a railway was made which had been a comparative failure, and had not relieved the traffic of the Sunderbunds in any way. With regard to the silver question, the key to the problem was that no tea or coffee was produced in a gold country, and therefore those industries were unaffected, except in so far as the low price had increased consumption. The reason Indian wheat had been affected was because the bulk of wheat was produced in gold countries, and as the rupee bought as much wheat or labour as before, the gold countries went down and India went up. Mr. Dipnall seemed apprehensive that, in consequence of the immense yield of tea, the soil would be exhausted, and an inferior article would be produced; but he need have no fear of that. He was drinking much stronger and better tea now than ever before, and in the future, when all the tea came from India, it would be immeasurably better than at present. Although brokers spoke of some depreciation in Indian tea, he had watched it closely for nearly 27 years, and was quite sure that the tea now produced was far better than when they got 1s. 10d. or 2s. a pound for it. More scientific knowledge was brought to bear upon it; it was all made by machinery, and the tea of this season was superior to that made twenty, fifteen, or even ten years ago. Mr. Hughes was a very distinguished chemist, but his remarks had been to a great extent answered by Surgeon-General De Renzy. Manure was used to some extent both in Assam and Chittagong, and certainly in the North-West Provinces and the Kangra Valley, but in nearly all these cases they were not virgin soils, but had been used by the ryots before to grow crops of rice and dahl. In such places ordinary farmyard manure was very useful, and he had known it to treble the crop. They did not know what might happen in the future, but he supposed some nitrogen was obtained from the atmosphere, and at any rate, as far as the experience of the Assam Company went, instead of showing any signs of giving out, every year showed a few pounds increase. This would probably go on for the next hundred years, or perhaps two centuries. It was not the lateral roots which supplied the nutriment to the plant, they were constantly being cut about by the hoe; it was the top roots which went down twelve or fifteen feet into the soil which the coffee plant would never touch. That was the reason why worn-out coffee plantations made admirable tea gardens.

The Chairman then proposed a hearty vote of thanks to Mr. Berry White. The mistakes made in the early days, the alternate manias and panics, were very similar to what had occurred more recently in the initiation of the gold mining industry. Dr. Pringle had referred to some of the companies being crushed under the weight of capital, and just the same thing had occurred in gold mining in Mysore. That point illustrated the value of such meetings as the present of the Indian Section of the Society, and of various other societies in England, which brought together men of various occupations and experience, all interested in Indian matters, to discuss such points. This would be one great advantage of the Imperial Institute, where all such information would be concentrated. To-night they had heard gentlemen of experience in Assam, others acquainted with the practical requirements of the tea trade in Mincing-lane, and distinguished chemists. All suggested points in which improvement might be effected, and it was obvious that the bringing together of these various forms of knowledge must

be of the utmost benefit to the interests of India. On one point he thought he might correct Mr. White, who said that if the rupee were to rise to 2s. it would diminish the purchasing power of the working clasess in this country. He did not wish to travel into the great silver question, but he thought Mr. White, on reflection, would agree with him that the same causes which might bring up the value of the rupee to 2s., would also bring up the wages of the working classes in exactly the same ratio, and would thus give them a purchasing power equal to the additional 3d. per pound on tea. Mr. Martin Wood had alluded to the need for migration from the congested to the less populated districts of India, and he held that was one of the most important questions which would have to come before the Indian Government in the near future. He learned that the Secretary of State appreciated its importance, and had reason to hope that the conecting link of railway of about forty miles between Assam and the congested districts of Behar and the North-West Provinces would soon be made; and when this was done, the people of these provinces would soon diffuse themselves over the fertile valleys of the Brahmaputra and Surma. With regard to Ceylon, he had some tea gardens there, and looked forward to a greatly increased cultivation. But Ceylon was only like a suburb of India, and the prosperity of each would go on side by side.

The vote of thanks was carried unanimously, and briefly acknowledged by Mr. BERRY WHITE.

Miscellaneous.

ALBERT MEDAL.

The following leading article on the award of the Albert Medal appeared in the *Times*, Tuesday, June 7th:—

The Albert Medal of the Society of Arts, for the year 1887, has been awarded by the Council of the Society to the Queen; and, at a meeting of the Council held yesterday, it was officially announced that the President, the Prince of Wales, had formally confirmed the award, and that her Majesty had signified her consent to accept the medal. The Albert Medal was founded in the year 1862 as a memorial of his Royal Highness the Prince Consort, who was for eighteen years the President of the Society; and it is directed by the bye-laws to be awarded annually for "distinguished merit in promoting arts, manufactures, or commerce." The recipient may be of any nation; and it has always been the practice of the Society to take a somewhat wide view of the question, and to look to the indirect, as well as to the direct, results of individual activity. A precedent for the presentation of the medal to a reigning Sovereign was early established, the first award, in 1864, having been made to Sir Rowland Hill "for his great services in the creation of the penny postage, and for other reforms of the postal system, the benefits of which have extended over the civilised world;" and the second in the following year, to his Imperial Majesty, Napoleon III., for "distinguished merit in promoting, in many ways, by his personal exertions, the international progress of arts, manufactures, and commerce, the proofs of which are afforded by his judicious patronage of art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects." Of the twenty-one subsequent awards, eight have been to foreigners; and it would be difficult to find any greater names among the men who in this country have signalised themselves in the arts of peace. Faraday, Cooke and Wheatstone (jointly), Sir Joseph Whitworth, Liebig, de Lesseps, Sir H. Cole, Sir H. Bessemer, Chevreul, Sir W. Siemens, Michael Chevalier, Sir G. Airy, Jean Baptiste Dumas, Sir W. Armstrong, Sir W. Thomson, Professor Hofmann, Pasteur, Sir Joseph Hooker, Captain Eads, Henry Doulton, and Samuel Lister complete the tale; and it will be seen that the principles governing the selection have been of the most comprehensive character. The award to her Majesty expresses the conviction of the Council that the fifty years of her reign have been such as to foster art and industry, to elevate taste, and to establish conditions which have rendered the conquests of science more accessible to all ranks, from the highest to the lowest, than they could have been in any less favourable circumstances. The throne has been so filled as to increase the strength and stability of the national fabric, and the personality of the Sovereign has been a potent agency in the promotion of every good and useful work. The Queen's acceptance of the medal will confer additional lustre upon it and upon the Society, as well as upon all who in future years may be distinguished in a similar manner.

The award of the Albert Medal, which, in the nature of things, can hardly be received otherwise than as the crown of a long career of usefulness and honour, can hardly be said to exert any active influence in the promotion of the efforts which it serves to mark and to commemorate. It is, nevertheless, a fitting thing that the selection of the recipient should be intrusted to the Society of Arts, a body which has been active for good during what is now, comparatively speaking, the long term of its existence. Many of the most important industrial steps of the century have been first made known at the meeting-room in the Adelphi, either by those with whom they originated, or in the many and various lectures which have been delivered under the endowment of Dr Cantor; and the Society has been no less useful by the manner in which it encouraged technical education long before the necessity for such encourage-

ment had come to be recognised by general public opinion. Nor must it be forgotten that the organisation which it possesses is such as to afford very complete securities against the neglect of any kind of merit. The Council, with whom the selection rests, is itself recruited from a very wide field, and always contains representatives of many kinds of knowledge; while it has been the praiseworthy custom to ask for the suggestion of names not only from members of the Society of Arts itself but also from foreign academies and institutions, and from the councils and presidents of English learned societies. In this way it is scarcely possible for any valid claim to be overlooked; while an additional security is afforded by a bye-law which requires the presence of twelve members of Council when the award is made, and the concurrence of nine of them in the selection. Besides this, the award must be confirmed by the President, with whom there therefore rests, by implication if not explicitly, a power to object, and to require from the Council a statement of the considerations by which they have been guided. It can afford no surprise that a distinction thus safeguarded should be a matter of high ambition among all who have any kind of claim to aspire to it; and the recommendation of both English and foreign learned bodies have been frequently made with an earnestness which sufficiently demonstrated their feeling upon the subject. It has been the custom that the medal should be given by the President in the presence of the assembled Council; and a meeting for this purpose has usually been held at Marlborough House; but it will be in the recollection of our readers that the Prince of Wales conferred upon Mr. Doulton the honour of going to the works at Lambeth, and of giving him the medal in the presence not only of the Council but of the assembled artists and potters in his employment. Of the ceremonial which will be observed on the occasion of the presentation to the Queen it would, of course, at present be premature to speak.

It would be impossible to glance over the list of persons which we have given above without some consideration of the mighty advances in human knowledge, and the vast additions to human welfare and convenience which have been the direct issue of their labours. The Albert Medal dates only from the last half of the reign, but what changes does it not commemorate! Before its establishment worthy recipients had, so to speak, accumulated; and the first awards were to men whose work was already in great part finished. Rowland Hill, Faraday, Cooke, Wheatstone, de Lesseps, and Thomson, collectively represent the changes which have occurred in the methods of communication between individuals and countries, or the rise of the present postal, telegraphic, and telephonic services. Whitworth represents the accuracy of measurement which has rendered it possible to make the parts of machinery interchangeable, or to construct from written descriptions a portion of an engine which may be conveyed to the Antipodes, and fitted into its allotted place. Liebig, Chevreul, Dumas, Joule, Hofmann, and Pasteur represent the influence of physical science, sometimes in its most abstruse forms, upon the actual management of industries which afford maintenance to thousands of people. Bessemer, Siemens, and Armstrong represent practical metallurgy; Hooker represents the utilisation of innumerable vegetable products; Cole, the Science and Art Department and the South Kensington Museum; Chevalier, the influence of political economy; Airy, the increased safety of navigation; and Eads, the advances which recent years have witnessed in the maintenance and improvement of waterways. There is not one of these great developments which does not serve to lighten the daily life of every inhabitant of any civilised country, which does not increase comfort, afford pleasure, and cheapen necessaries. At the rate of modern progress there need be no fear that but each recurring period of election will bring to the Council of the Society of Arts an embarrassing abundance of fitting claimants rather than a scarcity of them; and there can be no doubt but that the gracious consent of her Majesty to add her name to the illustrious list of the recipients will greatly enhance the future value of the award. While those who have already received the medal represent, as we have said, the departments of science or of industry in which they have become famous, the Queen may be held to be in this case the personal embodiment of the nation, and to represent the aggregate of its work. In her hands the medal will be a fitting memorial of the beneficial changes which have occurred since she assumed the sceptre, and of the multitudinous benefits which her people have received under her sway.

Correspondence.

KOLA NUTS.

Mr. Morris, in the course of his criticisms upon Sir Augustus Adderley's paper, stated that there was no demand for kola nuts, and he now adduces in support of that contention, a letter from Mr. H. Arnold, the buyer for my old friends and clients, Messrs. Burgoyne, Burbidges, Cyriax, and Farries. Unluckily, the evidence of the eminent firm just named, in place of supporting Mr. Morris's case, has simply demolished it. On my offering to buy half-a-hundredweight of kola nuts (for experimental purposes) at the price mentioned in that letter, Mr. Arnold informed me that they could not be sold, except at a loss, for much less than 8d. per lb., and, further, that his letter was written respecting kola as a drug only, from a Mincing-lane standpoint. In no way could he offer an opinion upon the nut as a

food, since the Liverpool imports of kola do not come within his purview.

That kola, now in considerable and almost weekly increasing demand, must, eventually, as Sir Augustus Adderley said, be "destined to play an important part in commerce," can scarcely be doubted, if we bear in mind its very remarkable composition. This is, I believe, the only vegetable product which combines within itself the nutritive properties of cacao, the stimulating properties of tea or coffee, as well as certain "sustaining" powers peculiar to itself. I therefore need not apologise for presenting the following tolerably complete analysis of kola, by which its special characteristics are shown far better than could be done in a page of mere description.

ANALYSIS OF KOLA NUT.

	Per cent.	
Alkaloids or crystallisable principles :—		
Caffeine	2·710	
Theobromine	·084	
Bitter principle	·018	
Total alkaloids	——	2·812
Fatty matters :—		
Saponifiable fat or oil	·734	
Essential oil	·081	
Total oils	——	·815
Resinoid matter (*sol. in abs. alcohol*)		1·012
Sugar :—		
Glucose (*reduces alkaline cuprammonium*)	3·312	
Sucrose? (*red. alk. cupram. after inversion*)*	·602	
Total sugars	——	3·914
Starch, gum, &c. :—		
Gum (*soluble in H_2O at 90° F.*)	4·876	
Starch	28·990	
Amidinous matter (*colouring with iodine*)	2·130	
Total gum and fecula	——	35·999
Albumenoid matters		8·642
Red and other colouring matters		3·670
Kolatannic acids		1·204
Mineral matter :—		
Potassa	1·415	
Chlorine	·702	
Phosphoric acid	·371	
Other salts, &c.	2·330	
Total ash	——	4·818
Moisture		9·722
Ligneous matter and loss		27·395
		100·000

I myself, have not the slightest commercial interest in kola, either directly or indirectly, but I may add to my observations of the other night, that both the French and German Governments are introducing it into their military dietaries, and that in this country several large contract-orders cannot yet be filled owing to insufficiency of supply, while a well-known cocoa manufacturing firm has taken up the preparation of kola-chocolate upon a commercial scale.

W. LASCELLES-SCOTT.

APPLIED ART SECTION.

MR. CAVE THOMAS writes :— The terms, "Applied Art," and "Applied Arts," may possibly be sufficiently understood by painters, sculptors, and architects, but the classification adopted by the late Sir Henry Cole, the "Fine Art Manufactures," would be better understood by the many; moreover, "Applied Art" is not a sectional, but a general term. All fine art is applied art, art applied to painting, to sculpture, to architecture, to mural decoration, &c. We should recollect, too, that the word "art" is applicable to the mechanical as well as to the fine arts, and the question naturally arises whether there be any great generalisation that formulates the aim of all art, that of the fine arts as well as that of the mechanical? There is—and it may be thus concisely expressed—adaptation to purpose, that adaptation to purpose which, in its complete fulfilment, constitutes perfect fitness. The exaltation of the beautiful, to the disparagement of the fit, is the demoralising art tendency of modern æstheticism. The good old English practice of aiming at perfect fitness would have led the fine arts, and the art manufacturers, into the right path. The Greeks recognised the principle of adaptation to purposes as the true art-motive, hence the chaste simplicity that characterises all their works. The beauty of the oviform was shown to be an accident of the organic fitness of the egg, the mere coincidence of its appositeness to taste—the form itself may be separated, or divorced, from the natural fitness of the organism to which it belongs, and may be used in a number of different ways for the gratification of the eye, and for many purposes with which it had originally nothing to do. Now this separation or divorcement of the beauties of nature from the organisms of which, scientifically speaking, they were the accidents, is an important function of fine art. We not only separate the oviform, but the human form, and other beautiful forms from the organisms, the organic fitnesses in nature to which they belong, and employ them in fine art productions. How, then, it may be asked, are we to reconcile the fine arts with the principle of adaptation to purpose? In this wise, every work of fine art has some purpose of its own to subserve, a purpose determined chiefly by its subject, and in proportion as it fulfils this end is it successful, and if the end be great, is it fit and excellent. The satisfaction of the critical judgment, of good taste, is an end and purpose in itself. The greatest works of fine art now existing have been rated excellent from their adaptation to their purposes as works of art. Moreover, when we come to apply fine art to utilities, the critical taste demands that it have some consistent relation to them, although the forms of the utilities themselves be merely used as pegs, or pretences, on which to hang fine art, as in the case of Flaxman's Achilles Shield, the Portland Vase, &c. The principle of adaptation to purpose is as applicable to works of literature as it is to the plastic arts. Let societies and individuals, however, strive as they may to promote good taste, little or no progress will be made towards a higher development of the fine arts, and of the art manu-

* Inverted by boiling with a 2·5 per cent. solution of citric acid for 10 minutes.

factures, till a consensus of educated opinion be brought to bear upon them. A discriminating demand by the titled and by the wealthy for their continuous production has ever proved a most potent and effective stimulus to excellence. In default of such a demand, any attempt to force art by technical procedure will, in a great measure, prove abortive, as well as a waste of time, and a waste of money.

General Notes.

Steel Production.—According to the Annual Report of the American Iron and Steel Association, the production of steel ingots in Great Britain and in the United States in 1886, including Bessemer, open-hearth, crucible, and other kinds, shows an aggregate of 2,364,670 gross tons for this country, and 2,562,502 tons for the United States.

Dresden Confectionery Exhibition.—Preparations are being made at Dresden for holding in August next an International Confectionery Exhibition, which will include every branch of bakery and confectionery, sweetmeats, chocolate, biscuits, gingerbread, as well as flour-grinding. Wines, spirits, and spices used by confectioners will also be represented.

Production of Salt.—In a paper on the manufacture of salt near Middlesborough, read by Sir Lowthian Bell, before the Institution of Civil Engineers, the author said that at the Clarence Works experiments had been made in utilising surplus gas from the adjacent blast furnaces, instead of fuel, under the evaporating pans, the furnaces supplying more gas than was needed for heating air, and raising steam for iron-making. By means of this waste heat from 200 to 300 tons of salt were now obtained.

Home Arts and Industries Association.—The annual exhibition of work done in the classes of the Home Arts and Industries Association, including wood carving, repoussé and metal work, embossed leather, mosaic, chalk carving, pottery, embroidery, lace, handspun linen, cloth, &c., will be held at the hall, 43, Cadogan-terrace, S.W., on Wednesday, 15th June, from 3 p.m. to 7 p.m ; Thursday, 16th June, from 2 p.m. to 7 p.m.; Friday and Saturday, 17th and 18th June, from 2 p.m. to 7 p.m., and 8 p.m. to 10 p.m. H.R.H. the Duchess of Teck will open the Exhibition.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 13...Geographical, University of London, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m.

Tuesday, June 14...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Joseph Rabino, "The Statistical Story of the Suez Canal."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m.
Colonial Institute, Prince's-hall, Piccadilly, W., 8 p.m. Colonel Sir Francis W. De Winton, "Colonisation."
Horticultural, South Kensington, S.W., 11 a.m. Scientific and Fruit and Floral Meetings.

Wednesday, June 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Conversazione at the South Kensington Museum.
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Francis J. Waring, "Amount and Distribution of Monsoon Rainfall in Ceylon generally, with remarks upon the Rainfall in Dimbula." 2. Mr. H. S. Eaton, "Note on a display of Globular Lightning at Ringstead Bay, Dorset, on August 17th, 1876." 3. Dr. John W. Tripe, "Ball Lightning seen during a Thunderstorm on July 11th, 1874." 4. Prof. T. G. Bonney, "Appearances of Air Bubbles at Remenham, Berkshire, January, 1871."
United Service Inst., Whitehall-yard, S.W., 3 p.m. Admiral P. H. Colomb, "Blockade, under existing Conditions of Warfare."
Botanic, Regent's-park, N.W., 2 p.m. Summer Exhibition."

Thursday, June 16...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 .pm. 1. Mr. C. B. Clarke, "Flora of Munipoor and Kohima." 2. Mr. H. J. Veitch, "Orchid Fertilisation." 3. Mr. J. G. Baker, "Ferns of Borneo." 4. Mr. K. Ito, "Japan Fungi." 5. Mr. H. Bolus, "South African Botany."
Chemical, Burlington-house, W., 8 p.m. 1. Professors W. Ramsay and S. Young, "The Thermal Constants of a Liquid Mixture." 2. Mr. W. H. Perkin, Jun., "Derivatives of Hydrindonaphtene and Tetrahydronaphthalene." 3. Messrs. F. S. Kipping and W. H. Perkin, Jun., "The Formation of Closed Carbon Chains in the Aromatic Series." 4. Dr. P. C. Fraser and Mr. W. H. Perkin, Jun., "The Action of Ethylene on Ethylic Sodacetoacetate." Dr. H. G. Colman and Mr. W. H. Perkin, Jun., "Derivatives of Pentamethylene." 6. Dr. P. C. Freer and Mr. W. H. Perkin, Jun , "Derivatives of Hexamethylene," 7. Dr. P. C. Freer and Mr. W. H. Perkin, Jun., "An attempt to Synthesize a Carbon Ring."
Chemical and Physical Society, University College, W.C., 8 p.m. Prof. A. W. Williamson, "A few words on Atomic Motion."
Historical, 11, Chandos-street, W., 8½ p.m. Captain C. R. Conder, "The Historical Connections of the Hittites."
Numismatic, 4, St. Martin's-place, W.C., 7 p.m.
Anglo-Jewish Exhibition, Royal Albert Hall, S.W., 8½ p.m. Dr. Graetz, "Jewish Parallels, having regard to Anglo-Jewish History."

Friday, June 17....Philological, University College, W.C., 8 p.m. Paper by Prof. Terrien de La Couperie.

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No. 1,804. Vol. XXXV.

FRIDAY, JUNE 17, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-third Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 29th June, at 4 p.m.

(By order of the Council)

H. Trueman Wood,
Secretary.

Proceedings of the Society.

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening last, 15th June.

The Galleries containing the Raphael Cartoons, the Sheepshanks Collection, the William Smith Collection of Water Colour Drawings, the Dyce and Forster Pictures, and "The Chantrey Bequest," were open.

The Reception was held in the South Court by Captain Douglas Galton, C.B., D.C.L., F.R.S., Chairman, and the following Vice-Presidents and Members of the Council:—Mr. R. Brudenell Carter, F.R.C.S., Mr. Charles Cheston, Mr. Francis Cobb, Mr. T. R. Crampton, Sir Juland Danvers, K.C.S.I., Prof. Dewar, F.R.S., Colonel Donnelly, R.E., Mr. W. H. Preece, F.R.S., Sir Robert Rawlinson, C.B., and Mr. Owen Roberts.

Promenade concerts were given by the band of the Royal Artillery (Conductor, Cav. L. Zaverthal) in the North Court, and by the band of the Royal Horse Guards Blues (Conductor, Mr. Charles Godfrey) in the Court-yard of the Museum.

BAND OF THE ROYAL ARTILLERY

1. March .... "Prodana Nevesta" .... Smetana.
2. Overture ...... "Dichter und Bauer" ...... Suppé.
3. Valse............... "Wiener Blut"............... Strauss.
4. Selection........... "Il Trovatore" .... Verdi.
5. Pizzicato........... "Al Fresco" .... L. Zavertal.
6. Song........."For Ever and For Ever" ...... Tosti.
   (Cornet Solo.)
7. Selection..............."Rigoletta"............. Verdi.
8. Gavotte .... "Mignon" .... Thomas.
9. Song .... "Gute Nacht" .... Küchen.
   (Cornet Solo.)
10. Selection.................."Faust"................ Gounod.
11. Pizzicato .... "Sylvia" .... Delibes.
12. Overture.............. "Masaniello"............ Auber.

God Save the Queen.

BAND OF H.M. HORSE GUARDS (BLUES).

1. Overture............ "Don Giovanni" ... Mozart.
2. Valse............... "La Cavaliere" ...... P. Perrot.
3. Selection............ .. "Dorothy" .... A. Cellier.
4. Viennese Dance .... C. Malemberg.
5. Glee............ "The Chough and Crow" Sir H. Bishop.
6. Selection from Balfe's Opera .... C. Godfrey.
   "The Bohemian Girl."
7. Valse......................... "Nina" .... Waldteufel.
8. Piccolo Solo "Breakmorn in the Forest" Bonnisseau.
   Mr. Smith.
9. Selection (Comic Opera) "Glamour." Hutchison.
10. Scherzetto .... Maude V. White
11. Valse............ "Crême de la Crême"... C. Godfrey.
12. Selection..............."Ruddigore"......... Sir A. Sullivan.
13. Galop . ... "Berlin" .... Michaelis.

A vocal and instrumental concert was given by scholars of the Royal College of Music, by permission of the Director, in the Lecture Theatre. The programme was as follows:—

Part I.

(9.15 p.m. to 10.15 p.m.)

Quartett in E flat.. Schumann.
Sostenuto assai, Allegro man non troppo, and Molto vivace.
Messrs. Barton, Sutcliffe, Kreuz, and Squire.

Songs { a. "The First Meeting" .... Grieg.
b. "My Mother bids me bind my hair" Haydn.
Miss Anna Russell.

Violin Solo .... Barcarole and Scherzo ...... Spohr.
Mr. Sutcliffe.

'Cello Solo .... { a. Romance........... ... Davidoff.
b. Tarantelle .... Popper.
Mr. Squire.

Part II.

(10.45 p.m. to 11.30 p.m.)

Piano Solo.......... "Ballade in A flat"......... Chopin.
Mr. Barton.

Song .... "Deh Vieni" .... Mozart.
Miss Anna Russell.

Viola Solo .... "La Nuit"............... Vieuxtemps.

Quartett in E flat .... Schumann.
Andante cantabile and Vivace.
Messrs. Barton, Sutcliffe, Kreuz, and Squire.

The number of visitors attending the *Conversazione* was 3,800.

Miscellaneous.

THE SOCIETY OF ARTS AND THE COLONIES.

The Society of Arts, from its first institution, has devoted very special attention to the advancement of the Colonies, and to the increase of their trade with the mother country. For a considerable period of its history the chief Colonies of this country were those in North America (now the United States).

NORTH AMERICA.

In the first scheme of the Society the Colonies are specially mentioned, and in the official observations on the effects of the rewards bestowed in the class of Colonies and Trade, it is remarked:—"The Society, influenced by the tenor and spirit of sundry Acts of Parliament, subsisting for more than a century past, and being of opinion that to encourage in the British Colonies the culture and produce of such commodities as we must otherwise import from foreign nations, would be more advantageous to the navigation and commerce of this kingdom than if the like things could be raised within the island of Great Britain, have liberally extended their premiums and bounties for sundry articles suited to the climates and circumstances of the North American provinces."

A few years before the Society of Arts was founded, Benjamin Franklin had issued "A Proposal for Promoting Useful Knowledge among the British Plantations in America," and in 1755 the Society elected him a corresponding member. Franklin, in acknowledging the compliment, expressed his wish to assist in the giving of "premiums for some improvements in Britain, as a grateful though small return for your most kind and generous intention of encouraging improvements in America."

As early as 1755, Dr. Gardener, of South Carolina, drew the attention of the Society to the want of machinery in the Colonies, and urged its introduction in these words:—"The land is entirely tilled by the hoe, and the rice planted by the hands of slaves, but the worst comes last, for after the rice is thrashed they beat it all in the hand in large wooden mortars to so clean it from the husk, which is a very hard and severe operation, as each slave is tasked at seven mortars for one day, and each mortar contains three pecks of rice."

Premiums were offered in 1755 for the plantation of mulberry trees in Georgia, with the view of providing food for silkworms. The same premiums were next offered for plantations in Carolina, and shortly afterwards premiums for the silk itself were substituted for those far the plantation of mulberry trees.. Connecticut and Pennsylvania were also included in the offer of these premiums.

After these attempts to encourage the production of silk, endeavours were made to produce wine in the American Colonies. In 1763, Mr. Charles Carter sent a dozen bottles of two kinds of wines from grapes which grew in vineyards of his own planting in Virginia. One of these samples was the product of vines brought from Europe, and the other of American wild vines. The gold medal was awarded by the Society to Mr. Carter, as the first who had made a spirited attempt towards the accomplishment of their views respecting wine in America. Two hundred pounds in 1768 were given to Mr. Edward Antill, for vines planted for making wine near Brunswick, N. America. The Earl of Stirling received a gold medal in 1769, for planting 2,100 sets for wine; and Mr. Christopher Sherb, fifty pounds in 1771, for planting and cultivating vines in South Carolina, and producing wine from them.

Besides these endeavours to assist the production of wine and silk in the American Colonies, considerable attention was given to the introduction of other commodities. Premiums were offered for for the production of potash—"For the greatest quantity of good merchantable potash, not less than twenty tons weight, that shall be produced in, and imported from, the Colonies of Nova Scotia, New Hampshire, Massachusetts Bay, Rhode Island, and Connecticut, considered as one entire district, into the port of London, one hundred pounds. For the next greatest quantity, not less than ten tons weight, fifty pounds." The offer was extended to the Colonies of New York, New Jersey, and Pennsylvania, considered as one district, and to the Colonies of Virginia, Maryland, North Carolina, and Georgia, considered as another district. These offers attracted considerable attention, but the large amounts required were not produced without difficulty, and in 1766 the Assembly of New England entered into communication with the Society as to the best means for improving the manufacture of potash in America. The cultivation of logwood, of olive trees, of isinglass, of opium, of indigo, and several other important substances was favoured by the Society. In 1766, application was made to the Society by several coopers to give assistance in promoting the importation of pipe staves from America in place of those brought from Germany. The committee which was appointed to consider this matter found that at least £100,000 was annually paid for staves imported from

Germany, and that Quebec oak made into staves would answer all the purposes of the German.

In 1783, an account was given of the amounts awarded in premiums, from which it appears that, up to that date, £2,785 13s. 8d. had been expended, and 14 gold medals awarded by the Society as rewards in the class of Colonies and Trade. Of this amount, £175 was spent for importing earth nuts, myrtle wax, sturgeon, and zebra wood; £50 for making indigo, iron, and saltpetre; £1,665 18s. 2d. for planting vines and mulberry trees, and producing silk and cotton; and £894 15s. 6d. for establishing manufactures of potash and pearl-ash. In this year, 1783, one hundred pounds was offered for the greatest quantity of merchantable nutmegs, not less than five pounds weight, being the growth of his Majesty's dominion in the West Indies, and nearly equal to those imported from the islands of the East Indies. The gold medal was offered to those who should bring into the port of London the greatest number of plants of one or both species of bread fruit tree in a growing state, and premiums were also offered for considerable quantities of oil obtained from cotton seed. In 1807, a silver medal was awarded to Mr. William Bond, of Canada, for his observations on the culture of hemp and other useful information relative to improvements in Canada, and the sum of twenty guineas was voted to Mr. Ezekiel Cleall for his machine for beating out hemp seeds and flax seeds, which was expected to be useful in Canada.

The silver medal, set in a broad gold border, was presented to Mr. Charles Frederick Grece, of Montreal, in 1809, for the culture and preparation of hemp in Lower Canada. The premiums, however, were offered for several years subsequent to this date for the cultivation of hemp in Upper and Lower Canada, in Nova Scotia, and New Brunswick. A gold medal was also offered to the master of a vessel who should bring to this country not less than one hundred tons of hemp, the produce of Upper Canada, or of one of the above-mentioned provinces. In 1816, Lieut.-Colonel Joseph Bouchette, Government Surveyor to the Commission for settling the boundaries between the British Colonies in North America and the United States, presented an extensive survey or map of Canada to the Society, for which he received the gold medal.

Mr. William Green, Secretary of the Literary and Historical Society of Quebec, communicated to that Society, in 1827, a paper on colouring materials produced in Canada, accompanied by a box of colours prepared from these materials. The paper and box were sent to the Society of Arts at the instance of the Earl of Dalhousie, Governor of Canada, and the Society awarded the gold Isis medal to Mr. Green for the pigments, which were pronounced by authorities to be good.

West Indies.

The West India Islands also came in for a large amount of the consideration of the Society. The production there of cochineal, of cinnamon, of the mango tree, and of several other important substances was encouraged. In 1773, a gold medal was presented to Mr. George Young, surgeon, in the island of St. Vincent, for superintending the formation of a botanic garden in the island. It is stated, as a note to the award, that "an extensive piece of ground, as various to aspects and soils, in the gift of the Governor, was granted for the purpose by General Melvill, who further entered into considerable expense for clearing, enclosing, and cultivating the same as a garden, from a public-spirited disposition to promote the views set forth in the advertisements of the Society."

The Society continued to take an interest in the Royal Botanic Garden at St. Vincent, and Dr. Alexander Anderson communicated a catalogue of plants in the gardens in on September 24, 1806, which is published in the *Transactions*. (Vol. 25, p. 191.) In 1828, the gold Ceres medal was given to the Rev. Lansdown Guilding, of St. Vincent, for an important paper on the insects infesting the sugar-cane in the West Indies, which is also printed in the *Transactions*. (Vol. 46, p. 143.)

The Society offered premiums for the finest samples of nutmegs or mace, not less than twenty pounds weight, grown in any part of his Majesty's dominions in the West Indies, or in any British plantation on the coast of Africa, or of the several islands adjacent thereto, or in the island of Singapore, and equal to those imported from the islands of the East Indies; and in 1830, the large gold medal was awarded to Mr. David Lockhart, botanical gardener to the Government of the Colony of Trinidad, for twenty pounds of nutmegs grown by him in the island.

Great interest was felt in England about 1820 in the spread of tea culture in our Colonies, and the Society of Arts took the matter up. A gold medal was offered to the person who should communicate, from information obtained in China, the best and most authentic account of the culture of the plant or plants, the leaves of which furnish the different kinds of tea, together with the method of gathering, drying, and otherwise preparing the leaves. The gold medal, or fifty guineas, was offered to the person who should grow and prepare the greatest quantity of China tea, of good quality, not being less than twenty pounds weight, in the island of Jamaica, or in any other British West Indian Colony, and should import the same into Great Britain. The same premium was offered for the Colonies of the Cape of Good Hope, the Mauritius, and New South Wales.

Africa.

In the early years of the Society's existence, information was received as to the production of cotton in Senegambia, and it was thought well to assist the importation of this cotton. Therefore, in 1767, the Society offered a gold medal for the greatest quantity of clean, merchantable cotton, the growth of any of his Majesty's settlements on the coast of

Africa, imported by private adventurers into any of the ports of Great Britain, not less than ten tons. A silver medal was also offered for a quantity not less than five tons.

Africa did not after that time meet with much attention from the Society until, in 1823, an attempt was made to foster the growth of the vine at the Cape. A gold medal was offered to the person who should import, in the years 1824, 1825, or 1826, the finest wine, not less than twenty gallons of good marketable quality, made from the produce of vineyards at the Cape of Good Hope, or the parts adjacent. It was announced that this premium was not offered for the sweet or Constantia wine, but to encourage the improvement of the vineyards more recently established. This premium was awarded to Mr. Francis Collison, of the Cape of Good Hope, for wine of superior quality, the growth of that Colony. Mr. Collison sent half a pipe of wine, and stated that about three hundred pipes of the same quality had been sent by him for sale in the London market. "The wine was examined at the Committee by dealers and other competent judges, and was considered by them to be far superior to the Cape wines in general. It is free from the unpleasant, earthy flavour by which such wines are usually characterised, and was considered to bear a near resemblance to that made at Teneriffe."

New South Wales.

In 1821, attention was first called to the wool-producing capabilities of New South Wales, and premiums were offered by the Society of Arts. These were responded to, and in 1824 the large gold medal was awarded to Mr. J. McArthur, of Sydney, for the importation of the greatest quantity of fine wool, the produce of his own flocks; and the large silver medal to Mr. Hannibal McArthur, for the importation of the next greatest quantity of fine wool. In this same year, the sum of thirty guineas was awarded to Mr. T. Kent, for preparing and importing from New South Wales extract of mimosa bark for the use of tanners. The thanks of the Society were also presented to Mr. R. W. Horton, M.P., Under-Secretary for the Colonies and Vice-President of the Society of Arts, for sundry articles from New South Wales which he had presented.

It has already been shown how the Society attempted to foster the production of wine in North America and the Cape of Good Hope, and attention must now be drawn to the attempt in the same direction in respect to New South Wales. The gold medal was offered to "the person who shall import, in the years 1824 and 1825, the finest wine, not less than twenty gallons, of good marketable quality, made from the produce of vineyards in New South Wales." This was announced in 1822, and in 1833, the large silver medal was presented to Mr. Gregory Blaxland for wine, the produce of his vineyard at Paramatta. "On examination by the Committee, it appeared to be a light but sound wine, with much of the odour and flavour of ordinary claret, or rather holding an intermediate place between that wine and the red wine of Nice. The general opinion seemed to be that although the present sample, from the inexpertness of the manufacture and the youth of the vine, is by no means of superior quality, yet it affords a reasonable ground of expectation that by care and time it may become a valuable article of export." From a memorial to Governor Maquarrie from Mr. Blaxland, in October, 1818, printed in the *Transactions* (vol. 41, p. 286), it appears that he was preparing his land for a vineyard in September, 1816. In 1828, the gold Ceres medal was presented to Mr. Blaxland for a pipe of wine, the produce of his vineyard in 1827. "On tasting the samples, it was the general opinion that both of them are decidedly better than the wine for which, 1823, Mr. Blaxland obtained the large silver medal of the Society, and that they were wholly free from the earthy flavour which unhappily characterises most of the Cape wines. The colour of the wine is a tawny red." The prize was still offered for wine from Australia in 1845. In 1830, the large gold medal was voted to Sir John Jamison, President of the Agricultural Society of New South Wales, for his method of extirpating the stumps of trees in order to clear the forest land for cultivation. The silver medal was awarded to Mr. James King, of Sydney, in 1834, for his discovery of a sand in New South Wales, eminently fitted for the manufacture of the finer kinds of glass.

India.

Equally with the Colonies, the plantations in the East Indies shared the attention of the Society of Arts, and special premiums were offered for the advantage of the British Settlements. Dr. William Roxburgh, Superintendent of the Botanic Garden at Calcutta, sent, in 1811, a sample of India-rubber from Bengal, and also a paper on the teak tree of the East Indies, then used for shipbuilding. He also communicated suggestions on the means of supplying food to the natives of India when the rice crop proves deficient. The thirty-third volume of the *Transactions* contains a portrait of Dr. Roxburgh, who died in 1815, and an account of his labours. Subsequently, Dr. Wallich, Superintendent of the Botanic Garden at Calcutta, communicated to the Society a full catalogue of Indian woods (*Transactions*, vol. 48, p. 439). In connection with the introduction of an india-rubber from Bengal, mention may be made of the first introduction of gutta percha from Singapore. Dr. Montgomerie sent a specimen to the Society in 1843, and in 1845 a gold medal was awarded to him for the introduction of this substance into England. In 1815, the gold Isis medal was awarded to Mr. Thomas Hoblyn, for preparing rice in the island of Ceylon by means of improved machinery Many other medals were given by the Society in order to promote the production of various commercial substances in the East Indies, and particular

attention was given to fibres, silk, and tea. In 1788, Sir Joseph Banks suggested to the Court of Directors of the East Indian Company the practicability of cultivating the tea plant in British India; but it was not until 1834 that the subject was submitted to his Council by Lord W. Bentinck, Governor-General. In 1835, information arrived in Calcutta that the tea plant was found indigenous in some districts in Upper Assam, and in 1838, the Chairman of the East India Company sent a sample of this wild tea to the Society, which was referred to the Committee of Colonies and Trade. Subsequently, the Society awarded the gold medal to Mr. C. A. Bruce, "for his meritorious services in discovering the indigenous tea tracts, and cultivating and preparing tea in Assam." It will be remembered by readers of the *Journal* that Mr. Berry White, in his paper on the "Indian Tea Industry," denies to Mr. Bruce the honour of being the first discoverer of the tea plant in Assam (see *ante* p. 735).

It is not necessary to follow this subject further here, as the work of the Society at a later date in connection with the Colonies and with India will be found in the pages of the *Journal* in the reports of the Indian and Foreign and Colonial Sections.

BRITISH ASSOCIATION.

The fifty-seventh annual meeting of this Association will be held at Manchester, and will commence on Wednesday, August 31, 1887. The first meeting of the General Committee will be held on Wednesday, August 31, at 1 p.m., for the election of the president and sectional officers, and the despatch of business usually brought before that body. The General Committee will meet again on Monday, September 5, at 3 p.m., for the purpose of appointing officers for 1888, and of deciding on the place of meeting in 1889. The concluding meeting of this committee will be held on Wednesday, September 7, at 1 p.m., when the report of the committee of recommendations will be received.

The first general meeting will be held on Wednesday, August 31, at 8 p.m. precisely, when Principal Sir William Dawson, C.M.G., M.A., LL.D., F.R.S., will resign the chair, and Sir H. E. Roscoe, LL.D., M.P., F.R.S., President-elect, will assume the presidency, and deliver an address. On Thursday evening, September 1, at 8 p.m, a soirée; on Friday evening, September 2, at 8.30 p.m., a discourse on "The Rate of Explosion in Gases," by Professor H. B. Dixon, M.A., F.R.S., F.C.S.; on Monday evening, September 5, at 8.30 p.m., a discourse on "Explorations in Central Africa," by Colonel Sir Francis de Winton, K.C.M.G., R.A.; on Tuesday evening, September 6, at 8 p.m., a soirée; on Wednesday, September 7, the concluding general meeting will be held at 2.30 p.m.

The following is a list of the sectional officers:—*A.*—Mathematical and Physical Science—President, Professor Sir R. S. Ball, M.A., LL.D., F.R.S., Astronomer Royal for Ireland; Secretaries, R. E. Baynes, M.A. (Recorder); R. T. Glazebrook, M.A., F.R.S.; Professor H. Lamb, M.A., F.R.S.; W. N. Shaw, M.A. *B.*—Chemical Science — President, Edward Schunck, Ph.D., F.R.S.; Secretaries, Professor P. Phillips Bedson, D.Sc. (Recorder); H. Forster Morley, M.A., D.Sc.; W. Thomson, F.R.S.E. *C.*—Geology — President, Henry Woodward, LL.D., F.R.S.; Secretaries, J. E. Marr, M.A.; J. J. H. Teall, M.A.; W. Topley (Recorder); W. W. Watts, B.A. *D.*—Biology—President, Professor A. Newton, M.A., F.R.S.; Secretaries, C. Bailey, F.L.S.; F. E. Beddard, M.A.; Walter Heape (Recorder); W. L. Sclater, B.A.; Professor H. Marshall Ward, M.A. *E.* — Geography — President, Major-General Sir Charles Warren, R.E., G.C.M.G., F.R.S.; Secretaries, Rev. L. C. Casartelli, M.A., Ph.D.; J. S. Keltie; H. J. Mackinder; E. G. Ravenstein (Recorder). *F.*—Economic Science and Statistics — President, Robert Giffen, LL.D.; Secretaries, Rev. W. Cunningham, B.D., D.Sc., (Recorder); F. Y. Edgeworth, M.A.; T. H. Elliot; Professor J. E. C. Munro, LL.D. *G.*—Mechanical Science—President, Professor Osborne Reynolds, M.A., LL.D., F.R.S.; Secretaries, C. F. Budenberg, B.Sc.; W. Bayley Marshall, E. Rigg, M.A. (Recorder). *H.*—Anthropology—President, Professor A. H. Sayce, M.A.; Secretaries, G. W. Bloxam, M.A. (Recorder); J. G. Garson, M.D.; A. M. Paterson, M.D.

Correspondence.

KOLA NUTS.

Before replying to the letter of Mr. Lascelles-Scott, there are one or two points to be noticed in reference to the letter from Mr. Thos. Christy, which appeared in your last *Journal*. That gentleman states that my valuation of 3d. to 4d. per pound for kola nuts was written to the best of my knowledge in regard to the fortnightly auction sales; such was not entirely the case, my valuation was based upon what I knew had been, and probably would again be realised for this article both in public and private sales; but even supposing that the price of 4d. per pound had only been obtained in the public drug sales, what further criterion of the market value of the article does Mr. Christy look for? With regard to that gentleman's statement that "kola nuts came to Liverpool, and are sold there," one would infer that a regular market was established there for this produce. The following report, from a well-known firm of brokers in that city, tends to show that the market there is even in a more precarious condition than

here :—"Your note to hand *re* kola nuts ; none here, and there is no inquiry at present; they only come in small lots, and at very irregular times, no record has been left of imports ; demand is very uncertain, and value has varied accordingly ; when there has been no chance of selling, lots have, at different times, had to be thrown away, as they do not keep, soon becoming rotten." This statement is also confirmed by another Liverpool broker. These facts seem to me to entirely disprove what Mr. Christy says, viz., "that the demand for sound kola nuts is far beyond the supplies."

The letter of Mr. Lascelles-Scott does not throw any light upon the present market value of kola nuts. It is quite true that I asked Mr. Lascelles-Scott 8d. per pound for half a hundredweight of kola nuts, but in discussing the value of this article one does not expect retail quantities to be placed upon the same basis as market quantities, and I would here remind that gentleman that my original valuation was based upon the question. "Would an importer find a ready sale, and if so, at what price for a quantity of kola ?"

HENRY R. ARNOLD.

26, Coleman-street, London, E.C.,
June 9th, 1887.

Mr. Christy's letter in the *Journal* for June 3 fully confirms the views expressed by me respecting kola nuts. There is no regular quotation for them ; the demand is uncertain and spasmodic, and, therefore, the planters in the West Indies, tempted by Sir Augustus Adderley's recommendation to invest in the cultivation, are liable to find both their time and money thrown away. This is all I wished to say, and, so far, nothing has been gained by Mr. Christy, except indicating the source of the information contained in Sir Augustus Adderley's paper.

The merits of kola nuts, *per se*, I do not touch. They may have, or they may not have a future. At present it is purely conjectural. Under these circumstances was it wise to recommend without qualification a purely speculative cultivation to small growers in the West Indies, when plenty of others, with certain returns, were within their reach ?

It may be not out of place also to point out, in reply to both Mr. Christy and Mr. Lascelles-Scott, that the idea of making chocolate from kola nuts was first suggested in my "Annual Report on the Public Gardens of Jamaica," in 1882. This was nearly two years before it was taken up by Mr. Christy.

Coffee in parchment, and also in cherry, has been exported on trial from the West Indies, but the prices offered by the merchants were too low to be remunerative. Hence the growers prefer to pulp and clean their coffee themselves, and so place it in the market at first hand. They are evidently the sole judges of what pays them best.

D. MORRIS.

9th June, 1887.

CAOUTCHOUC-YIELDING PLANTS.

The remarks which appeared in the issue of the *Journal* for June 3, on "The Useful Plants of Mauritius" are important to those who take an interest in the flora of Mauritius, and more especially to those who would like to see our Colonies producing those vegetable products which we are obliged to seek elsewhere.

I wish, however, to point out an important omission which deserves attention. Of course, in a botanic garden, it is impossible to find room for everything, and I would venture to say that our Colonial friends in this respect are too exclusive; a great deal is left outside for want of space, attractiveness, apparent absence of utility, and difficulty of adapting a "place" suitable for the *locale* of a botanical "ragamuffin." Instead of concentrating attention to making a garden neat and prim, and cultivating what, *a priori*, is known to do well, it would be better to turn some attention to the cultivation of those plants which are not indigenous, but from which important products are obtained. This need not interfere with the present arrangement of making a botanic garden pleasant to the eye and enjoyable as a promenade, &c.

A few years ago I met with a gentleman who had spent some time in this island. He informed me that on some elevated rocky parts, which were almost destitute of vegetation, a creeping plant grew in luxuriance, the juice of which contained a large quantity of caoutchouc. From his description, I concluded that this plant was probably a creeping or trailing *Apocyna.*

It seems to me that it is very desirable to clear this matter up, for if a caoutchouc-yielding plant can be so easily grown on such a spot, we have a very simple way of utilising land which is not likely to be productive as it is, and which is beyond the reach of any ordinary agricultural process of being reclaimed.

The *Mangifera indica* (see "Useful Plants of Mauritius") is also said to grow on this island. It would be interesting to know if this plant is botanically allied to the *Mangabiera* (*Hancornia speciosa*), which yields Pernambuco and Ceara rubber. The geographical and climatological conditions of Mauritius seem favourable for the cultivation of this plant, provided it is grown on land with an ordinary good subsoil. It stands long drought fairly well at Ceara.

We must bear in mind that West African rubber is principally obtained from varietie sof *Apocyna*, which are natives of Madagascar. Some varieties of this class of rubber are fairly good ; this fact makes it more difficult to understand why an article of higher commercial importance cannot be produced generally.

I am surprised to find that some writers on botany say that the *Vincæ* and *Neria* do not produce lactescent juices, and hence are devoid of caoutchouc. Our common garden periwinkle contains it, and when I was in Demarara, a few years ago, I was

struck with the amount of caoutchouc contained in the *Oleander*.

It would be interesting to know whether any of our own herbaceous or subshrubby plants, which are known to contain caoutchouc, could be profitably cultivated in warmer latitudes.

There are instances of plants, which are herbaceous in this country, having arborescent representatives in warm climates. The *Euphorbiaceæ* is a familiar illustration, one species of which yields the Para rubber; our common representative is a weed called the "Caper Plant." I remember planting out a number of these seedlings some years ago at Mitcham, and was surprised at the amount of lactescent juice which the mature plant yielded. The juice contained caoutchouc in rather large quantity.

I prepared in 1861 a quantity of caoutchouc obtained from the flower stem of the common dandelion, and it was exhibited at Guy's Hospital *soirée*. I was led to extract this from the report of an analysis of the juice of this plant contained in Dr. Pereira's "Materia Medica."

The best way of preserving these specimens is to place the caoutchouc in ether containing a small quantity of alcohol. In this mixture caoutchouc remains white and unaltered for a long time; exposed to the air, even in well-stoppered bottles, it rapidly turns brown.

I may note here that the *Chicoraceæ*, although lactescent, are said by some writers not to contain caoutchouc; these remarks respecting taraxacum are in contradiction to this. The common sow-thistle also contains this principle, although in smaller quantity. The *Sapotaceæ*, although lactescent, do not yield caoutchouc, at least I have not met with a single case in proof of its being otherwise. The concrete juices of these plants are called in commerce "butters," and consist mainly of fatty or oleaginous principles. Galam butter is obtained from a plant belonging to this order, *Bassia Parksii* (being first mentioned by Mungo Park).

THOMAS T. P. BRUCE WARREN.

Notes on Books.

THE HEALTH OF NATIONS. A Review of the Work of Edwin Chadwick, with a Biographical Dissertation. By Benjamin Ward Richardson. London: Longmans, Green, & Co. 1887. Two vols., 8vo.

In dealing with the work of Mr. Chadwick, Dr. Richardson had before him what he calls an original library—"a library which the most industrious scholar could not, I think, read through with any hope of being master of it in less than two or three years. . . . The first instalment to this library dates, as near as I can learn, from the year 1828 . . . the latest instalments bear the date of the year 1885-6." With such a mass of material, Dr. Richardson found it impossible, in the space at his disposal, to give an exhaustive review of all the essays before him. He writes therefore—"What I undertake to do is to select for review, from the essays, such portions as contain the substance of the whole, so that the all-important teachings may be rendered apart from the masses of detail." In considering the work of Mr. Chadwick as a whole, the editor finds two ideals—unity and prevention, and in all the treatises the idea of unity is for the prevention of evil. The contents of the two volumes are thus arranged. The first volume is devoted to *Directive Science*, subdivided as (*a*) Political and Economical, and (*b*) Educational and Social. The second volume deals with *Preventative Science*, subdivided as (*a*) Prevention of Disease: Sanitation (*b*), Prevention of Pauperism: Poor-law Administration (*c*), Prevention of Crime: Police Administration. Prefixed to the first volume is a short biography of Mr. Chadwick.

EXERCISES IN WOOD-WORKING FOR HANDICRAFT CLASSES IN ELEMENTARY AND TECHNICAL SCHOOLS. By William Cawthorne Unwin, F.R.S London: Longmans, Green, and Co. 1887.

Professor Unwin, finding a want in the case of his own pupils for a series of drawings for their use, has here produced a selection of exercises for workers in wood. The pupils having a very limited time at their disposal, it was found necessary to make the exercises so simple as to involve only one or two difficulties at a time. The author explains the principle upon which he has worked in the following words:—"The drawings form a series of graduated exercises. They begin with small simple pieces of jointing, in which, as only a single pair of pieces are united, the labour and difficulty are reduced to a minimum. When a selection of these joints has been made, the pupil will understand how pieces of wood are united together, in what directions pieces so united resist separation, and what is the relative labour of making each kind of joint. The next series of exercises consist of simple frames of four joints; the difficulty here is a good deal greater, because each joint must not only be accurately formed, but must have the proper position in relation to the rest."

ESTETICA DEL CANTO E DELL' ARTE MELODRAMMATICA (Esthetics of the Art of Singing and of the Melodrama). By E. Delle Sedie. Livorno. 1885. Four vols.

This work consists of a series of lessons on the use of the voice, which the author hopes may be easily applied in schools of singing and melodramatic declamation. The first book deals with general notions of music, the second with physio-

logical notions on the voice, the third with studies of expression and modulated singing, and the fourth with the study of singing applied to words. The fifth lesson of the fourth book is on action on the stage, which is illustrated by a number of figures showing the various positions necessary for a proper dramatic expression. The book is printed in Italian, French, and English.

Obituary.

COLONEL CROLL.—Colonel Alexander Angus Croll, who died at Dunblane, N.B., on 7th inst., at the age of 76, had been a member of the Society of Arts since 1843. He was a native of Perth, and on removing to London, he became connected with the Great Central Gas Company, and other similar undertakings. He held the position of Chairman of the United Kingdom Electric Telegraph Company, and in 1871 he was publicly presented with a testimonial of plate, of the value of 1,000 guineas in recognition of his services. He originated and erected the pile of buildings in the City of London forming the Wool Exchange. Colonel Croll was a deputy-lieutenant and magistrate, and had served the office of Sheriff of London and Middlesex. He was honorary colonel of the 2nd Tower Hamlets Regiment of Engineer Volunteers. As a magistrate for several counties, Colonel Croll took much interest in questions relating to prison discipline, and he was the author of a pamphlet on productive prison labour. Colonel Croll was a member of the Council in the years 1873-75, and held the office of Examiner in Gas in the Technological Examinations of the Society.

General Notes.

IRON STATISTICS.—There were last year, according to the official returns of the Luxemburg Chamber of Commerce, in the Grand Duchy 60 iron mines in activity, producing, with 3,025 hands, 2,361,372 tons of oolitic ore similar to that of Cleveland. Of the 21 blast furnaces, 20 were in blast for 797 weeks, producing 400,644 tons of pig-iron with 1,732 hands. The number of foundries, including that of the new Dudelange Steel Works, is 7, which with 178 hands, turned out 2,585 tons of castings, of which, 2,141 consisted of columns, floor-plates, and parts of engines and machines. The two rolling mills at Luxemburg and Dudelange produced 28,154 tons of finished iron and steel, with 401 hands.

IMPERIAL INSTITUTE.—It is announced that the foundation stone of the Imperial Institute will be laid at South Kensington by Her Majesty the Queen on Monday, July 4th, at half-past twelve o'clock. Subscribers of five guineas and upwards to the Fund for the establishment and endowment of the Imperial Institute will be provided with two free tickets for seats for a lady and a gentleman. Application must be made for these tickets, either personally or by letter, on or before Wednesday, June 22nd, at the offices of the Imperial Institute, 1, Adam-street, Adelphi, London, W.C.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 20...Asiatic, 22, Albemarle-street, W., 4 p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Annual Meeting.

TUESDAY, JUNE 21...Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. Günther, "Report on a Zoological Collection made by the Officers of H.M.S. *Flying Fish*, at Christmas Island, Indian Ocean." 2. Mr. F. E. Beddard, "On a Point in the Structure of *Myrmecobius*." 3. Professor F. Jeffrey Bell, "Studies in the Holothuridea—VI. Description of new Species." 4. Mr. A. Smith-Woodward, "On the Fossil Teleostean Genus *Rhacolepis*."

WEDNESDAY, JUNE 22...Geological, Burlington-house, W., 8 p.m. Papers by Mr. O. A. Derby, Miss C. A. Raisin, Prof. T. M'K. Hughes, Mr. W. S. Gresley, Mr. J. W. Hulke, Mr. E. A. Walford, Mr. J. V. Elsden, Baron von Ettingshausen, Mr. T. T. Groom, and Mr. J. Spencer.
Royal Society of Literature, 21, Delahay-street, S.W., 1 p.m.

THURSDAY, JUNE 23...Anglo-Jewish Historical Exhibitions, Royal Albert hall, Kensington-gore, S.W., 8½ p.m. Rev. D. Gaster, "Jewish Sources of the Arthur Legend."

FRIDAY, JUNE 24...United Service Inst., Whitehall-yard, 3 p.m. Captain W. H. James, "Fire Discipline, and the Supply of Ammunition in the Field, as Provided for by Foreign Powers."
Quekett Microscopical Club, University College, W.C., 8 p.m.
New Shakspere, University College, W.C., 8 p.m. (Annual Meeting.) Paper by Mr. Ernest Radford.

SATURDAY, JUNE 25...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Professors W. E. Ayrton and J. Perry, "Note on Magnetic Resistance." 2. Messrs. W. Stroud and J. Wertheimer, "Sounding Coils." 3. Mr. E. C. Rimington, "Comparing Capacities." 4. Professor Herbert Tomlinson, "The Effects of Change of Temperature in Twisting or Untwisting Wires which have Suffered Permanent Torsion." 5. Professors W. E. Ayrton and J. Perry, "Permanent Magnet Ammeters and Voltmeters, with Invariable Sensibility."
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Society of Arts.

No. 1,805. Vol. XXXV.

FRIDAY, JUNE 24, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1887.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1886	754	0	9			
,, Do. in hands of Secretary	26	18	4			
				780	19	1
,, Subscriptions received during the year from Members and Institutions in Union	6,270	7	0			
,, Life Compositions	567	0	0			
				6,837	7	0
,, Sale of India 4 per Cent. Stock (Mulready Trust) for re-investment				109	10	1
,, Dividends and Interest				715	18	1
,, Ground Rents				174	0	0
,, Examination Fees				237	1	0
,, House and Office (receipts for gas, &c.)				34	13	0
,, Advertisements				1,382	17	1
,, Grant from Royal Commission for the Colonial and Indian Exhibition for preparation of Reports				500	0	0
,, Sales—						
Barry's Etchings	4	6	0			
Cantor Lectures	14	11	7			
Conversazione Tickets (1886)	1,605	10	0			
Examination Papers	3	0	1			
Japanese Exhibition Catalogues		6	3			
Journal	171	19	0			
Public Health Conference Reports		6	0			
Spoiled Post-cards	2	7	5			
Transactions	1	6	4			
				1,803	12	8
				£12,575	18	0

Cr.

	£	s.	d.	£	s.	d.
By House and Premises:—						
Rent, Rates, and Taxes	353	15	4			
Insurance, Gas, Coal, House expenses, and charges incidental to ordinary meetings	253	3	1			
Repairs and Alterations	173	5	11			
				780	4	
,, Office:—						
Salaries and Wages	2,084	17	11			
Stationery, Office Printing, and Lithography	277	3	1			
Advertising	49	1	0			
Postage Stamps, Messengers' Fares, and Parcels	196	8	10			
				2,607	10	10
,, Library, Bookbinding, &c.				52	17	0
,, Conversazione (1886)				1,905	10	0
,, *Journal*, including Printing, Stamps, and Distribution				2,656	12	11
,, Advertisements (Agents and Printing)				567	5	9
,, Examinations				285	18	11
,, Memorial Tablets				8	13	2
,, Medals:—						
Albert	23	9	6			
Society's	25	16	0			
				49	5	6
,, Owen Jones Prizes				5	11	0
,, Cantor Lectures				247	8	8
,, Lectures (additional)				27	2	6
,, Juvenile Lectures				25	12	6
,, Sections:—						
Applied Art	2	11	5			
Applied Chemistry and Physics	72	18	0			
Foreign and Colonial	71	0	0			
Indian	64	1	0			
				210	10	5
,, Japanese Exhibition				127	17	6
,, Committees:—						
Art Workmanship Competition	1	1	5			
Musical Pitch		7	0			
Prime Motors	11	10	2			
General expenses	12	1	10			
				25	0	5
,, Reports on Colonial and Indian Exhibition	491	4	6			
,, Balance returned to Commission	8	15	6			
				500	0	0
,, Imperial Institute (expenses for collection of subscriptions, to be repaid)				38	9	3
,, Balance repaid to Union Centrale des Arts Décoratifs, Paris				20	7	0
,, Investment in Reduced 3 per Cent. Stock of Life Compositions of the year	567	0	0			
,, Do. in New South Wales 3½ per Cent. Stock (from income of the year)	500	0	0			
,, Do. in South Australia 4 per Cent. Stock (from income of the year)	514	14	2			
,, Do. do. (re-investment of Mulready Trust)	109	10	1			
				1,691	4	3
				11,833	1	11
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1887	722	16	9			
,, Do. in hands of Secretary	19	19	4			
				742	16	1
				£12,575	18	0

Liabilities.

	£ s. d.	£ s. d.
To Tradesmen's Bills	366 19 7	
,, Rates	50 0 0	
,, Examiners' Fees	137 13 6	
,, Sections:—Applied Art, Foreign and Colonial, and Indian	185 0 0	
,, Accumulations under Trusts	312 15 11	
		1,052 9 0
Excess of Assets over Liabilities		14,576 10 7
		£15,628 19 7

Assets.

	£ s. d.	£ s. d.
By Society's Funds invested in—		
Reduced 3 per Cent. Stock, £6,966 15s., worth on 31st May, 1887	7,140 18 4	
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, worth on 31st May, 1887	236 10 7	
£1,500 Queensland 4 per Cent. Bonds, worth on 31st May, 1887	1,560 0 0	
£500 Canada 4 per Cent. Stock, worth on the 31st May, 1887	545 0 0	
£530 10s. 1d. New South Wales 3½ per Cent. Stock, worth on the 31st May, 1887	529 17 10	
£500 South Australia 4 per Cent. Stock, worth on 31st May, 1887	517 10 0	
		10,529 16 9
,, Subscriptions of the year uncollected	749 14 0	
,, Arrears, estimated as recoverable	200 0 0	
		949 14 0
,, Property of the Society, including Barry's Pictures and Lease of House		2,000 0 0
,, Advertisements on the Books, due and in course of execution*		1,168 3 6
,, Due from Imperial Institute for expenses of collection of subscriptions		38 9 3
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1887		722 16 9
,, Do. on Deposit		200 0 0
,, Do. in hands of Secretary		19 19 4
		£15,628 19 7

* A portion of this sum is liable to charges for printing.

Investments, &c., Standing in the Name of the Society.

	£ s. d.
Ground Rents on Tyssen-Amherst Estate	£4,590 0 0
Consols	425 8 9
New 3 per Cents	388 1 4
Reduced 3 per Cents	7,724 10 11
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500 0 0
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150 0 0
Bombay and Baroda do. do.	2,450 0 0
Canada 4 per Cents	923 0 0
South Australia 4 per Cent. Stock	605 16 0
New South Wales 3½ per Cent. Stock	530 10 1
Great Indian Peninsular Railway 4 per Cent. Guaranteed Debenture Stock	2,170 0 0
Queensland 4 per Cent. Bonds	1,500 0 0
Cash on deposit with Messrs. Coutts and Co.	200 0 0

Trust Funds included in the Above.

		£ s. d.	
1.	Dr. Swiney's Bequest	£4,500 0 0	Invested in ground-rents, and chargeable with a sum of £200 once in five years.
2.	John Stock Trust	100 0 0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiène Prize	133 6 8	,, ,, ,, Interest as a Money Prize.
4.	North London Exhibition Trust	192 2 1	,, ,, ,, ,, ,,
5.	Fothergill Trust	388 1 4	New 3 per Cents., chargeable with the Award of a Medal.
6.	J. Murray, in aid of a Building Fund	54 18 0	Reduced 3 per Cent. Stock.
7.	Subscriptions to an Endowment Fund	562 2 2	Reduced 3 per Cent. Stock.
8.	Dr. Aldred's Bequest	140 15 9	Reduced 3 per Cent. Stock.
9.	Thomas Howard's Bequest	500 0 0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock.
10.	Dr. Cantor's Bequest	4,600 0 0	Bombay and Baroda and Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock.
11.	Owen Jones Memorial Trust	423 0 0	Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12.	Mulready Trust	105 16 0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,953 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock.
14.	Accumulated Interest on Trust Funds	200 0 0	On Deposit with Messrs. Coutts and Co.

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.

Payments set forth above have been made by authority of the Council.

The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

W. R. Malcolm, } *Treasurers.*
B. Francis Cobb, }

H. Trueman Wood, *Secretary.*

J. O. Chadwick, F.C.A., *Auditor.*

Society's House, Adelphi, 18th June, 1887.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-third Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 29th June, at 4 p.m.

(By order of the Council)
H. TRUEMAN WOOD,
Secretary.

HER MAJESTY'S JUBILEE.

The following completes to date the list of subscriptions by members of the Society of Arts to the funds for the Imperial Institute —

	£	s.	d.
Amount previously published	2,201	10	0
Robert Baker..	1	1	0
Septimus Brocklehurst	5	5	0
W. H. Cullingford	10	10	0
Hon. Sir Edmund Drummond, K.C.I.E.	2	2	0
Charles Edward, J.P.	1	1	0
Captain Kirwan J. Fernie	5	5	0
George C. Handford	10	10	0
George Norgate Hooper	30	0	0
Robert Hopwood Hutchinson	10	10	0
J. Archer Jackson..	1	1	0
Christopher J. Little	0	10	6
Miss M. Lovell	1	1	0
George Marrable	2	2	0
J. Lewis Thomas, F.S.A.	2	2	0
Thomas Twining	5	0	0
Total	2,289	10	6

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

Miscellaneous.

MEDALS OF THE SOCIETY.

At the period of the foundation of the Society of Arts, the art of medal making was in a depressed condition, and among the first undertakings of the Society was an attempt to improve the engraving of dies for medals, for which purpose prizes were offered. At this time Thomas Pingo, an artist born in Italy but subsequently appointed engraver to the English Mint, was one of the most distinguished medallists in the country. His two sons, John and Lewis Pingo, followed in the steps of their father, and these three carried off the chief prizes. John Pingo was afterwards appointed chief engraver to the Mint, and his brother Lewis was an assistant in the same establishment. In several instances the sons obtained the prizes for the dies, but the designs were mostly the work of Thomas Pingo, the father. Another medallist of distinction who was brought into notice by the offer of these prizes, was John Kirk, a pupil of Dassier, but he died at an early age in 1776, and no other artists of any particular promise appear to have been brought forward by the offer of these medals. The medals which were struck in connection with these prizes are quite distinct from the honorary medals of the Society presented to those who had furthered the objects of the Society, an account of which medals was given in a previous volume of the *Jouraal* (see vol. xxix., p. 850).

Although England was at peace when the Society was formed, it was not long before this peace was broken, and in May, 1756, war was declared with France. After some losses, a series of national victories commenced, which continued for several years, and presented striking subjects which were taken advantage of by the Society in offering prizes for medals. In October, 1758, John Pingo had produced, in answer to the advertisement of the Society, a model for a copper medal with a head of Britannia and this inscription round it, "O fair Britannia, Hail." On the reverse was the figure of Victory standing on the prow of a ship, with the inscription, "Louisburg taken, MDCCLVIII." This referred to the taking of Cape Breton by the English under Amherst and Boscawen, in July, 1758, an action which was highly appreciated in the country, and for which thanksgiving services were held in the churches. The medal was accepted by the Society, but before the year 1758 was out, the small island of Goree, on the Western Coast of Africa, was taken from the French by Admiral Keppel, and the glory of this achievement was supposed to eclipse that of the taking of Louisburg, and the Society therefore directed John Pingo to make a new die for the reverse of his medal, and to cause the words "Goree taken" to replace "Louisburg taken." There were, however, some medals struck with this latter inscription. In October, 1758, after deciding on the Goree medal, the Society, at the instance of the well-known Republican, Thomas Hollis, who took a particular interest in these medals, proposed as the subject for one "Liberty, with her attributes, on the face, and the Barons obtaining Magna Charta at Runnymede, on the reverse." A premium of ten guineas was offered for a medallion of three inches diameter, to be produced by youths under the age of twenty-two. Lewis Pingo received this premium for his wax model for a medal, exhibiting King John delivering Magna Charta to the Barons, 1215.

In 1759 there were further triumphs of the

British arms to record, so that it was not necessary to seek for incidents in the early history of the country. Wolfe took Quebec on the 13th of September, and in 1760 John Pingo received a premium for a medal with the inscription, "Quebec taken," and it was resolved that the name of Wolfe should be inserted under the military trophies, and the name of Saunders under the naval trophies. The French besieged Quebec in 1760, but were repulsed by General Murray, and they raised the siege on the 16th of May. On September 8th Montreal, with the whole of Canada, capitulated to Amherst, and the Society, wishing to commemorate an event which caused the mob in the streets to cry, "God bless the good news," offered a premium for another medal with the inscription, "Canada subdued." This prize was obtained by Lewis Pingo. In 1763, the Conquest of Canada was ratified and confirmed by the Treaty of Paris, 10 February, 1763. This event was commemorated by another medal of the Society, with the inscription, "The Conquest of Canada Completed," and the artist who produced the medal was John Kirk.

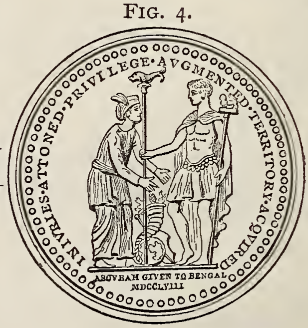
FIG. 1.

FIG. 2.

In 1761, a premium was offered to youths under twenty-two for a model for a medallion, "the face to represent North America with her attributes, and the reverse a group of American Indians offering presents, the produce of their country, to Britannia their protectress." In 1762 two medals were prepared in response to the offer of premiums, one in commemoration of the Battle of Minden, in Westphalia, fought in August, 1759, when the French were defeated by an army of Anglo-Hanoverian troops under Prince Ferdinand of Brunswick, and the other to record the brilliant exploit of Admiral Hawke off Belleisle, on the 20th November, 1759. It is not surprising that when the relative claims of these two victories came to be considered by the committee, the Society decided that the first prize should be given for the medal commemorating the naval achievement, and the second prize to that of Minden. On the obverse of the first of these medals was the inscription, "Britain triumphed, Hawke commanded, off Belleisle, Nov. XX., MDCCLIX.;" on the reverse were figures representing France and Britain, and Night and Tempest between them, with the inscription beneath, "France relinquishes the Sea." This medal was the work of John Kirk, and is a pleasing memorial of one of the most dashing achievements in English naval history. Admiral Hawke, who took charge of the British squadron in 1759, to cruise off the coast of Brest, was sick of inaction, but his opportunity came on the 20th of November, when he sighted the French fleet under Admiral Conflans, off Belleisle. Notwithstanding that the French, trusting to their knowledge of the rocks and shallows, retired towards the shore, he determined to engage them, and the French fleet was only saved from total destruction by the

FIG. 3.

FIG. 4.



approach of nightfall. This engagement is generally known as the Battle of Quiberon. The medal commemorating the battle of Minden was by John Pingo, and the obverse and reverse are shown in Figs. 1 and 2 (p. 766).

In 1762, John Pingo received fifteen guineas for a medal representing the Mother of the Arts imploring royal protection for her children, Painting, Sculpture, and Architecture. In 1763, John Taylor, jeweller, obtained a prize of ten guineas for the design of a medal representing America offering its products to Britannia as protectress; and in the following year the same John Taylor obtained the same sum for a design of Asia, with attributes, offering its products to Britannia as protectress.

In 1764, the subject given for a medal was the City of London personified, with her attributes; on the reverse, the figures of Fame and Isis with their proper attributes.

Subsequently when a premium was offered for a medal, an optional subject was announced as the "Harbour of Cherbourg destroyed Aug. 8, 1758;" or the Battle of Plassy, June 23, 1759. The latter of these two was designed by John Pingo, and the obverse and reverse of this medal are shown in Figs. 3 and 4 (p. 766). It will be seen that the distinguished commander, Clive, who vanquished 60,000 men, with 1,000 British and 2,000 Sepoys, and thus founded the British empire in India, obtains his due meed of honour by his name appearing on the obverse. The first inscription proposed for the reverse was "The Soubah of Bengal appointed," which was altered to "Britain gives a Soubah to Bengal," and again altered, as seen in Fig. 4, to "Injuries attoned. Privilege augmented. Territory acquired. A Soubah given to Bengal, MDCCLVIII." This refers to the appointment of Jaffier Ali, as Soubahdar or Governor of the Province of Bengal, in succession to Suraj ud Dowlah, who was defeated at Plassy. In Fig. 4 Clive is shown as a Roman general, holding a sceptre surmounted by a lion in his left hand, and with his right hand presenting to Jaffier another sceptre surmounted by a dolphin.

Although peace was concluded in 1763, the Society continued to give as subjects for medals incidents of the war; thus, in 1764, Lewis Pingo produced a medal with the inscription, "Guadaloupe surrendered May 1, 1759," on the obverse, and the names of Moore and Barrington on the reverse, the first being in command of the ships, and General Barrington of the army. Guadaloupe, one of the lesser Antilles in the West Indies, was restored to the French in 1763, but was repeatedly retaken by the English in subsequent years.

In 1771, a premium was offered for a medal to commemorate the victory of Admiral Boscawen obtained over the French Toulon fleet on August 18th, 1759, in the Bay of Lagos, and Lewis Pingo obtained this prize. In 1772, the subject proposed was the surrender of Havannah, although the city had been restored in 1763. Havannah was taken by George Lord Albemarle on the 14th of August, 1762, and great joy was shown by the public at the news of the victory; William Duke of Cumberland, writing to the victor, said, "Upon the whole no joy can equal mine, and I strut and plume myself as if it was I that had taken the Havannah." Again Lewis Pingo obtained the prize. After this it was resolved by the Society to discontinue the offer of premiums for models of medals.

The history of the country is written in its medals, and it will be seen from the above notes that, for several years of the last century, the annals of the Society were intimately connected with some of the most stirring incidents in that history.

STATUES OF COLONIAL WORTHIES.

Mr. C. Washington Eves has forwarded the following additions to the list of statues to eminent colonists, by Mr. J. S. O'Halloran, which appeared in the *Journal* of July 2nd and 9th last, so far as relates to the island of Jamaica (*See* Vol. xxxiv., pp. 863-65, 881-82):—

SIR NICHOLAS LAWES was Governor of Jamaica from 1718 to 1722. Monument erected inside the church of the parish of St. Andrew.

ADMIRAL LORD RODNEY was one of the most eminent of England's naval commanders. As a Rear-Admiral he commanded at the successful bombardment of Havre, and sailing to the West Indies, reduced Martinique. Another triumph, and one of the greatest in our naval annals, obtained him his peerage, viz., the memorable victory he achieved over the French Fleet, commanded by the Comte de Grasse, and in honour of which a well-executed marble statue was erected. This statue is now placed near the Market Building in Kingston, overlooking the harbour. The naval hero, in acknowledging the honour done to him by the people of Jamaica in erecting this statue, described the island as "the brightest jewel in the British diadem," a designation of which the inhabitants are still justly proud.

SIR CHARLES METCALFE (afterwards Lord Metcalfe) was Governor of Jamaica from 1839 to 1842. A statue was erected opposite to the principal entrance of Kingston Parade Garden, by "the grateful inhabitants of Jamaica, in commemoration of the benefits derived from his wise, just, and beneficial administration of the government of the island."

HON. EDWARD JORDAN, C.B., for a long series of years, and in times of danger, fearlessly stood forward as the champion of emancipation, and for the removal of civil disabilities. A full length marble statue was erected on the eastern side of the Kingston Parade Garden, bearing the inscription—"Erected by public subscription in humble acknowledgment of the important services rendered to his country" by the deceased, who "honoured by his

Sovereign, and beloved by the people, will ever be remembered as one of Jamaica's most distinguished sons."

Dr. Lewis Q. Bowerbank, a distinguished native-born physician and sanitary reformer, and in public life Custos of Kingston, "whose administration was a tradition and a model." Statue erected in 1881 on the northern side of the Kingston Parade Garden by his numerous friends and admirers. Born in Jamaica, 1814.

WINES OF TUSCANY.

Her Majesty's Secretary of Legation in Italy says that in some parts of the provinces of Tuscany it is not allowed to commence the vintage until the municipal authorities publish their permission to do so. In most parts, however, no restriction is imposed on the people, who often gather their grapes too early, on account of the frequency of rural thefts, from which the peasant is unable to save himself, except by a continued, difficult, and fatiguing watch over his property. In many places the vintage begins simultaneously, in consequence of an old-established custom like the ancient right of gleaning in England, by which all are free to enter the vineyards in search of grapes as soon as the gathering is finished Usually the grapes are all thrown together and pounded without being separated from the stalks. The owner receives from the tenant, or *métayer*, from 7 to 10 per cent. of the wine produced. During the transport of the grapes from the vineyard to the owner's house they are often exposed for many hours to the sun, which does not improve their condition. The grapes are trampled by peasants with naked feet, and much good wine is lost by this primitive progress. Careful proprietors use wooden wine-presses, but mechanical presses are hardly used at all. The best wines of Tuscany are the Chianti and Montepulciano. The latter is made with more than ordinary care, and consists of a mixture of about three-quarters of black to a quarter of white grapes. Three qualities of wine generally result in the vintage; the first quality, clear wine, goes to the owner; the second, *mezzo vino*, or *vino stretto*, usually belongs to the tenant; and the third, *vino piccolo*, is left to the peasants for the use of themselves and their families during the winter. Each barrel contains about 42 litres, and the glass *fiaschi* a little over two litres. Only choice wine is bottled and kept for two years before going to market. The better kinds of Tuscan wines undergo a second fermentation, and are then rectified with choice must, in the proportion of four to eight kilogrammes per hectolitre. This process is called the *governo*, and is said to ameliorate the taste and quality of the wine. The casks are usually made of chestnut wood, sometimes of oak. Not much *vin de luxe* is made, the best sorts being red and white muscat, *pomino* and *aleatico*.

EXHIBITION OF BUILDING MATERIALS, BRUSSELS.

A leading feature in the programme of the Belgian Society of Engineers and Manufacturers is the holding of special exhibitions, of which, besides the loan collection of M. de Lesseps' plans and models of the Suez and Panama canals, four have already taken place, viz., Iron and Steel Permanent Way for Railways and Tramways; Methods of Illumination Retrospective and Actual; Indiarubber and its Applications; and Telephonic Apparatus. These have been held in the Society's hall, forming part of the Brussels Bourse; and lectures connected with the subjects of exhibition or individual exhibits have been given on Friday evenings. Such has been the interest attaching to these exhibitions, that latterly they have been open to the public at a small fee.

The fifth exhibition, which remained open until the 19th June, was devoted to building materials found or made in Belgium, but excluding the metals, and has drawn together a large number of materials, a few of which merit notice on account of their interesting character or novelty. The Belgian marbles, which are largely exported to England for mantelpieces, are well represented, the Société Anonyme de Merbes-le-Château sending no fewer than twenty specimens. It may be mentioned, incidentally, that it is chiefly the red varieties, of which the Rouge Royal is a type, that are known in England; but the black with white veins also merit attention.

Specimens of the principal Belgian marbles, prepared, like microscope subjects for studying the origin and structure of the Devonian limestones, have been lent by the director of the Brussels Natural History Museum. They are only one-tenth of a millimetre thick, and have been prepared by grinding one face perfectly true and smooth, and cementing a glass plate to it, the other side being ground down to the desired thickness, and also protected by a glass plate. Placed in vertical frames, the specimens may be examined, with the aid of the magnifying glass, by looking through them towards the natural or an artificial light.

The floor shown by Damman and Cassard consists of shallow concrete arches turned between light rolled iron or steel joists, the concrete having internal dovetails left in its upper surface, which is made flat, and completely covers the joists. Over this surface liquid asphalte is poured, and while it is still hot the pieces of wood forming the *parqueterie* are bedded in it. Grooves are made in their longitudinal lower edges, two of them forming together an internal dovetail, so that when the asphalte sets it securely clamps the wood down to the concrete. The floor thus produced is solid and noiseless, while at the same time being sound proof, damp proof, and practically fire proof. A modification of the above, in which the *parqueterie* pieces are connected with asphalte to tiles having a conical hole in the middle of each, has been laid down at the Hôtel de Ville,

the Palais de Justice, and the Palais de la Nation, Brussels.

The Société Anonyme des Fours de Laeken makes hollow slabs of plaster of Paris for filling up the space between two rolled joists. The Société Anonyme des Deux Nèthes accomplishes the same object with *hourdis*, or slabs made of burnt clay, hollowed out in the direction of their length, and provided with longitudinal ribs or feathers for strength. Léon Champagne et Cie make for this purpose *voussettes*, or hollow bricks approaching in form to that of the wedge, which they claim to be quite as efficient and less costly.

Picha Frères, of Ghent, strengthen all their articles made of cement with a stout iron-wire framework inserted in the middle during their formation. Renette et Cie, of Ghent, sink wells in sandy soils with the aid of hollow cylinders composed of concrete, coated and lined with cement, which not only prevent accidents due to earth falling in while sinking, but also secure a pure supply by intercepting surface water. In sinking a well, the ground is first levelled; and then the bottom ring, having its lower edge splayed out and bevelled, so as to sink easily and make a way for the rest, is laid upon the surface. The earth inside is then excavated, when the ring sinks by its own weight. When its top is level with the surface, another ring is added; and the socket joint is cemented, so as to be water-tight. This process is continued until water is reached, when a special dome-shaped ring with aperture is placed on the top, without, however, being cemented, in case it should afterwards be found necessary to deepen the well.

A new roofing substance is shown by E. Perret, of Vilvorde, in his "unalterable cloth" for superseding the so-called bitumenised felt, which soon becomes disintegrated under a hot sun. The flax tissue is impregnated and coated with a bitumen derived from petroleum, to which are added small quantities of natural bitumen, resin and chalk; and the upper side is sanded to prevent adhesion when the cloth is rolled up. The cloth is laid on battens, or direct on the rafters, which may be 12 or 15 inches apart, the lower portion of a sloping roof being covered first with a continuous length. Another length is then laid above, with a 3-inch lap, and so on till the roof is covered, the upper length being folded over the ridge. The cloth is held down by washers of the same secured by zinc nails, and requires no coat of tar or other substance.

A new drying oil for house painters, to take the place, at half the cost, of linseed oil, dryers and turpentine, is prepared from petroleum by Rave, Annez et Cie. Besides the lower cost, the special advantage is that the oil dries so quickly that several coats may be applied in a day, a matter of great importance when a temporary structure is required in a hurry. It is asserted that the oil will unite chemically with all paints except white lead, which may be replaced by zinc white, and crome yellow, for which Naples yellow may be substituted. It is also claimed that this is the only oil that may without difficulty be laid on cement and combine with it, and through which tarred or bitumenised surfaces will not show.

COTTON AND VINE CULTIVATION IN BUSHIRE.

Consul Malcolm, in his last report, says that the cultivation of cotton in the environs of Bushire is somewhat peculiar as compared with the system existing in the interior, where the plants are annuals, and grown by irrigation, whereas in Bushire it is grown without any irrigation, and the plant lives up to twenty-five and thirty years without diminishing in yield. A plot of ground is ploughed up about three times during the rainy season, with the object of rendering the soil as soft as possible, then, just after the last rains, seeds first cleaned from every particle of the cotton, are soaked in water for two or three days, and then sown in furrows of about eight to ten inches deep, in rows of five or six feet apart. The seeds are thickly sown and covered over with earth; they begin to sprout in about ten days, and the plants are entirely left to the mercy of the elements, the only precaution taken being to prevent their being destroyed by cattle. With a heavy fall of rain after the sowing, the seeds, as a rule, die, or come up very sparsely, and fresh seeds have to be put down immediately. If the soil is rich and soft, the plants grow thickly, forming a sort of hedge, but as a rule only two or three plants survive in the space of a yard. The plants, if in good soil, begin to bear in the first or second year, and continue increasing in yield up to their fifth or sixth year, when they may be said to have arrived at maturity. During the successive rainy seasons, the space between the rows is carefully ploughed up, and grain is sown, with double advantage, the ploughing being considered highly beneficial to the cotton, and its dead leaves in time serving as manure for the grain. Cattle are allowed to enter the cotton fields towards the end of autumn, as it is considered that they perform the work of pruning. A healthy plant is estimated to yield cotton to the value of eightpence, but the average yield may be taken at one shilling for every six plants. The plants blossom first in May, and the cotton is collected in July, when they blossom immediately a second time, reopening in September. The rearing of the vine is also, according to Consul Malcolm, peculiar in Bushire. On a declivity, a well about four feet in diameter is dug to a depth of sixteen feet, and a space of five feet is filled in with fresh soil well manured; then a healthy layer of the vine is put down early in March. For the first month it is watered four times, and then less frequently, about twice a month, until the autumn. The reason of planting the vine in wells and on slopes is to prevent the scorching heat of the sun

striking at the roots, and also to permit of rain water to collect therein during the winter months, which is the only means of watering the plant. The vine begins to bear from the first year, but the bunches are plucked off for the first three years. The plant attains its maturity in six years, when its yield varies, according to the soil and the attention it receives, from one hundred and thirty to seven hundred pounds of grapes.

INDUSTRIES AND HANDICRAFTS IN CENTRAL AFRICA.

Handicrafts and domestic industries are neither numerous nor noteworthy in this part of the globe, yet a few deserve mention.

The Upper Nile boats are curious specimens of naval architecture; they have no ribs, but the planks are laid one on another, and large nails are driven diagonally from both sides. They are caulked with rags from the inside, and the seams are not payed with pitch; hence many leaks occur through rats pulling out the rags.

The only agricultural implement in the Bari country is a sort of hoe, shaped exactly like the ace of spades, fixed to a handle about 9 ft. long; this is pushed before the culturist as he walks, cutting the roots of the grass, and just scuffling the surface of the ground. The Fatiko hoe is similar to that used in the Bari country, but instead of being mounted in the same way, it is fixed to a short handle in such a manner that the hoe is nearly at right angles with the handle; this makes a very powerful instrument, digging into the soil for considerable depth.

In the Cazembe's country the people play on a kind of rude piano, called *marimba*.

Throughout Usmao the baobab (*Adansonia digitata*) flourishes remarkably; from its bark the people make very strong, pliable rope. In Ugara some of the streams are spanned by grass bridges, called *usisa*.

Palm oil is largely prepared in Uguha; and in localities producing china clay there are large pottery works. Rua and Manyuema turn out artistic iron work, and the famous grass or palm-fibre cloth. Cotton cloth is also made at several places, and various woods and barks are utilised for particular purposes—one kind for canoes, another for spear-shafts, a third for mortars, a fourth for pestles. Matting and baskets of many kinds, wooden bowls, dishes, and drums are largely manufactured. There are also blacksmiths and coppersmiths, but most of their metal wares are procured from the Warua. They have a species of cymbal imported from this tribe, made of iron in the shape of the letter U, and sounded by a piece of stick with a head of india-rubber.

The weapons of the Masai are spears (*omberi*), shields (*elongo*), swords (*ollalem*), clubs (*ologuma*), bow and arrows (*oluiandai*, *orseiyet*, *ombaia*), and knives (*ossirere*). They cut their own clubs from the roots of hard trees. The shield is made of ox skin, of oval shape, about 4 ft. 6 in. long, and 2 ft. wide in the middle. The hoes are made of "ebony." Formerly their spears and swords were made of hard wood, but now they import metal heads from their neighbours, to whom they are also indebted for the small metallic ornaments worn by the women, having no iron in their country, and no knowledge of working it. Their spear blades are 18 in. long, and 5 in. or 6 in. wide.

In Mambwe's country, on Lake Tanganyika, much iron ore is smelted. The kilns are larger than those used by the Ajawa and Manganja. They stand about 9 ft. high, and are 5 ft. in diameter at the base and 3 ft. at the top, and are built of clay plaster 4 in. to 6 in. thick. They will contain nearly half a ton of iron ore. Charcoal is used for smelting.

The Walunga are not behind other lake tribes in their industries. Excellent pottery, as well as baskets, is made in the country, and their millstones are built into a sort of solid table in one piece, with a pit or receptacle for the meal. Cotton cloth, too, is made in almost every village.

In Kairrondo the spears are long, and have short blades. The shields are made of buffalo hide, and are about 5 ft. high and 3 ft. wide. Neither swords nor knives are in use. The natives navigate the lake (Victoria Nyanza), their boats being made of planks, sewn or pegged together, and sometimes provided with a sail made of *basuti*, a coloured stuff imported from the coast.

There are blacksmiths in Ukara who manufacture hoes, axes, and spears. Cooking-pots of clay and wicker-work baskets are likewise produced.

The Waganda are celebrated for their basket-work. Baskets are even used as vessels to drink from, one great shallow basket being the family drinking cup. From the inner tissue of banana stems they make napkins and pocket handkerchiefs.

The granaries of some tribes on Lake Tanganyika deserve notice. They are built on posts, with floors raised about 3 ft. from the ground, 4 ft. to 12 ft. in diameter, and the largest 20 ft. high, without including the roof. Those for old corn are plastered over, and have a small hole under the eaves for access, which is reached by a notched trunk used as a ladder. Those for fresh corn are made of 11 ft. canes about 2 inches apart, with hoops of the same material every 2 ft. or 3 ft., thus allowing the air to pass through freely.

The fictile arts in the neighbourhood of Tanganyika have reached a high stage of development. The process adopted is as follows. First rough clay and water, for one pot, are beaten with a pestle like that used for corn, till they form a perfectly homogeneous mass. This is put on a flat stone, or in the bottom of another pot, and hollowed in the centre by a slap of the hand. The workman (or rather woman) then shapes the vessel roughly by the

hands kept constantly wet, smooths out the finger marks with a corn cob, polishes it all over with bits of gourd and flat wood, and ornaments it with a sharp-pointed stick. After drying for four or five hours in a shady place, it is stiff enough to receive the bottom, which is worked in from another piece of clay. A pot capable of holding two and a half to three gallons occupies about 45 minutes in manufacture. The shapes are very graceful and true, reminding one of the Pompeian amphora. The vessels are used for holding palm oil.

On the road between Dar es Salaam and the Nyassa country, rubber vines abound, and, apparently, are but little affected, except in the immediate neighbourhood of the villages, by the reckless mode of tapping employed. In many parts a native can still gather 3 lbs. of rubber daily. Another great staple of the district is copal, which is found in many parts. It seems that this fossil resin exists, even in the richest diggings, only in patches, as though it had been produced by isolated trees. The natives appear nowhere to work the country systematically, but to sink test holes, and, on finding traces of the resin in any part, to work that thoroughly. The resin now found underground, usually in red, sandy soil, is undoubtedly the produce of the same species of tree as still exists in these jungles, which now yields an inferior sort of resin; the difference between the two being the consequence of age, and a chemical or molecular change effected by time. The copal tree grows throughout the Uzamaro country, and is by no means confined to the sea coast, but is even more abundant inland, beyond the first coast ridge, not however after the limestone formations appear.

FRUITS OF SIERRA LEONE.

The following is from a report by the honorary secretary of the Sierra Leone Botanical Society on the fruits of that settlement, printed in the *Board of Trade Journal*:—

"The chief fruits grown in Sierra Leone, together with prices locally obtained, are as follows:—The pine-apple, sold at 10d. per dozen; the banana, sold at 8d. a bunch; the cashew; cocoanuts, sold at 6d. per dozen; the cucumber; the red guava, sold at about 2s. per bushel; the white guava; the lime, sold at 6d. to 8d. per hundred; the locust; the mango, sold at 3d. per dozen; the orange; the papaw; the pear, sold at 6d. to 9d. per dozen; the plantain, sold at 3d. to 8d. per bunch, and the black or velvet tamarind.

"The chief fruits exported in a green state are pine-apples, bananas, plantains, pears, mangoes, limes, and oranges, of which pine-apples constitute the bulk of the export to Great Britain and France. It would appear from the Custom-house returns that during the year 1883 as many as 68,792 pines were exported to the United Kingdom and France. This quantity could be annually maintained and considerably exceeded if the trade were remunerative, and the large quantities which are produced in the Timneh country induced to flow abroad through the settlement. But the loss sustained by the fruits arriving at their destination in bad condition has checked the continuity of the supply and growth of exports.

"Almost the whole of the bananas, plantains, pears, mangoes, limes, and oranges grown in Sierra Leone go to the Gambia, Goree, and Senegal, whilst some pines also are exported to those places.

"There is no export of preserved fruits, and cocoanut is the only fruit of the settlement exported in a dry state, and in that state, in which it takes the name of coprah, it is not used as fruit.

"But the waste of economic matter in the shape of shell, husk, and fibre thrown away after separation of the kernel for coprah, and perhaps the reduction in the price of coprah during the past four or five years, have stimulated the growth since last year of an export of cocoa-nuts in husk, chiefly to Europe, where the now neglected materials may be used in the manufacture of ropes and matting, and the kernel in its free state used as fruit.

"Besides the suggestion just made relative to cocoa-nuts, it is not unworthy of record regarding mangoe, that its abundance and cheapness here, and the capacity which Sierra Leone has for its increased production, are conditions which point to the necessity for studying how and where it may be turned to account as an article of export, either green to be used in the manufacture of spirits, which it is said may be profitably produced from it, or for composition as fruit, or in a dried or preserved state. When in a fresh state, and before it is fully ripe, it is employed locally as, and is found to be good substitute for, English apple sauce.

"Like pine-apples, the other exportable fruits above referred to may be produced in larger quantities than the present yield, but the drawbacks to their more extensive production, and to a greater investment in the fruit trade, are mainly for the Gambia, Goree, and Senegal, countries almost destitute of fruits, the want of regular steam communication with them, and of precision in the dates of arrival and departure of the steam vessels now taking freight from Sierra Leone; and for Europe, the absence of quick transit, as well as vessels specially adapted for receiving and conveying fruit.

"The export trade in two of the fruits of the settlement is likely to gain a new impetus, viz., cashew and velvet tamarind, for the stone of the cashew is in great demand in Germany, where it is used in confectionery, and is sold there at 9s. a cwt., though it is only thrown into the dust heap here. Velvet tamarind is being somewhat extensively used in pharmacy in France. The knowledge of the demand for these fruits in Europe is all that is necessary to infuse activity in their cultivation, and in their export hence."

Correspondence.

CAOUTCHOUC YIELDING PLANTS.

I should like to say a few words on Mr. Bruce Warren's letter on "Caoutchouc Yielding Plants," on page 760 of the *Journal* for June 17th, because some of the statements contained therein require explanation. In the first place, Mr. Warren does not seem to be aware that for many years past a considerable amount of attention has been given to the cultivation and acclimatisation of useful plants in the botanical gardens of our Colonies and in India. The whole thing has been taken up so thoroughly, especially of late years, and fostered at Kew, with which all the botanic gardens are in communication, that it has been reduced to a system. These are facts so well known that I need not dwell upon them; indeed it is for the purpose of answering some of Mr. Bruce Warren's questions, and setting some of his statements in a clearer light, that I now write.

Mr. Warren asks if the *Mangifera indica* "is botanically allied to the Mangabeira (*Hancornia speciosa*), which yields Pernambuco and Ceara rubber." In answer to this, allow me to say that the *Mangifera indica* is the mango tree of India, chiefly valued for its fruit, and belonging to the natural order Anacardiaceæ, while the *Hancornia speciosa*, the common name of which is Mangabeira, is a native of Pernambuco, and though the fruits are edible, the chief value of the tree is for the rubber which it yields, known as Pernambuco, and not Ceara rubber, which is furnished by a totally different plant, namely, *Manihot glaziovii*, a Euphorbiaceous tree. *Hancornia speciosa* belongs to the Apocynaceæ, an order well known for the elastic juice found in the stems of many of its species, which fact Mr. Warren seems to be aware of when he says that West African rubber is principally obtained from plants of this order. These plants are, however, natives of the East and West Coasts of Africa, as *Landolphia florida*, *L. Owariensis*, *L. Kirkii*, *L. Petersiana*, &c., and not of Madagascar, as stated by Mr. Warren.

In confirmation of Mr. Warren's statement that "there are instances of plants which are herbaceous, having arborescent representatives in warm climates," I need but mention the common castor-oil plant (*Ricinus communis*), which is an annual, 4 ft. to 5 ft. high in this country, while in Spain and Sicily it is a bush or small tree, and in tropical countries it becomes a tree 40 ft. high. This plant belongs to the Euphorbiaceæ, and shows the great variation we sometimes find in the same species, without the necessity of comparing two such totally distinct plants as the Para-rubber (*Hevea brasiliensis*), which is naturally a large tree, and the "caper plant," or caper spurge (*Euphorbia Lathyris*). It is one of the characteristic properties of the Euphorbiaceæ to yield milk or elastic juices. Mr. Warren refers to the lactescent character of plants belonging to the tribe Cichoraceæ of the natural order Compositæ. This milky juice, which is found in the dandelion and allied plants, dries and becomes hard on exposure to the air, and is not elastic. In its close ally, the lettuce, it is narcotic, and is known as lettuce opium.

Regarding the Sapotaceæ, though they do not yield caoutchouc pure and simple, they yield an analogous substance, namely gutta percha, the principal source of this being a sapotaceous tree (*Dichopsis gutta*). Many of the species, principally belonging to the genus *Bassia* as *B. latifolia*, *B. longifolia*, *B. butyracea*, all Indian trees, and *Bassia Parkii* of Western Africa, yield a quantity of fat from their seeds, generally known as vegetable butter. The character, therefore, of the Sapotaceæ is to give a solid fat from their seeds and an elastic juice or gutta from the stems.

JOHN R. JACKSON.

Museum, Royal-gardens, Kew, June 21, 1887.

KOLA NUTS.

I notice in your last number that Mr. Morris, of Kew, says that Mr. Thomas Christy supplied me with the information in my paper about the kola nut. It is right that I should say Mr. Christy never saw my paper until it was published, and that I consulted him in no way about it. About six months ago I sent an order for twenty tons for him to Trinidad; the order could not be filled.

A. J. ADDERLEY.

June 22, 1887.

Obituary.

COSMO INNES.—Mr. Cosmo Innes, M.Inst.C.E. secretary of the London Sanitary Protection Association, died on the 18th inst., at 11, Upper Phillimore-gardens, aged 45. Mr. Innes was the youngest son of the late Cosmo Innes, Professor of History in Edinburgh University. He was elected a member of the Society of Arts in 1880.

General Notes.

ANGLO-JEWISH HISTORICAL EXHIBITION.—The last two papers to be read in connection with this Exhibition, in the West Theatre of the Royal Albert Hall, will be on June 30, "The Chief Rabbis of England," by the Rev. Dr .H. Adler; and on July 4, "The Educational Work of the Jewish Community," by the Rev. S. Singer.

ANTHROPOLOGICAL INSTITUTE.—At a meeting on Tuesday, June 28th, the following communications will be read :—"1. "An ancient British Settlement excavated near Rushmore, Salisbury," by Lient.-General Pitt Rivers, F.R.S. 2. "The Stature of the older Races of England, as estimated from the long bones," by Dr. John Beddoe, F.R.S.

Journal of the Society of Arts.

No. 1,806. Vol. XXXV.

FRIDAY, JULY 1, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the report from the Council, and the Treasurers' Statement of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 29th instant, at four p.m., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Chairman of the Council, in the chair.

The Secretary read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Allen, W. A., 156, Choumert-road, Peckham, S.E.
Anderson, John, M.D., LL.D., F.R.S., 71, Harrington-gardens, S.W.
Boutall, Walter, 16, Clifford's-inn, W.C.
Buzzegoli, Joseph, 66, St. Augustine's-road, N.W.
Campbell, Hon. Dudley, 1, Mitre-court-buildings, Temple, E.C.
Charnock, Richard Stephen, Ph.D., Junior Garrick Club, Adelphi-terrace, W.C.
Clifford, Frederick, 24, Collingham-gardens, South Kensington, S.W., and 1, Plowden-buildings, Temple, E.C.
Currey, C. Herbert, 14, Great George-street, S.W.
Curtis, Robert Leabon, 120, London-wall, E.C., and City Carlton Club, E.C.
Ellwood, George, The Warren, Fairmile-park, Cobham.
Faviell, Frederick Henry, The Cottage, Loughton, Essex.
Gardner, J. Starkie, 29, Albert-embankment, S.E.
Gregory, Horatio, Wax Chandlers'-hall, Gresham-street, E.C.
Gregory, James Reynolds, 88, Charlotte-street, Fitzroy-square, W.
Henderson, James Stewart, 7, Hampstead-hill-gardens, N.W.
Hughes, Robert B., 90, Oxford-gardens, W.
Letheren, W., Art Manufactory and Iron Works, Cheltenham.
Norman, T. M., 67, New Bond-street, W.
Portal, William Richard, M.A., Tonge-house, York-road, Lower Norwood, S.E.
Propert, John Lumsden, M.R.C.S., 112, Gloucester-place, Portman-square, W.
Rodriguez, Epifanio, 12, John-street, Adelphi, W.C.
Rothschild, Lord, Tring-park, Herts.
Rutherford, John, J.P., Blackburn.
Sadler, George William, 467, High-st., Cheltenham.
Stoner, Alfred, 8, Blomfield-street, E.C.
Thomas, Charles Henry, 48, Pall-mall, S.W.
Urquhart, John William, 107, Market-street, Manchester.
Walker, John Scarisbrick, 3, Alexandra-road, Southport, Lancashire, and Pagefield Iron Works, Wigan.
Wallis, William Lumb, The Wish, Eastbourne.
Watson, James Proctor, Garth Morr, Castle Craddocks, Carlisle.
White, John Berry, Monkhams-hall, Waltham Abbey, Essex.
Wilson, Miss Bessie, Kent-end, Forest-hill, S.E.

The Chairman nominated Mr. P. Lund Simmonds and Mr. P. S. Reid, scrutineers, and declared the ballot open.

The Secretary then read the following:—

ANNUAL REPORT.

I.—Ordinary Meetings.

The papers which have been read at the Ordinary Meetings during the past Session will bear favourable comparison with those of any previous Session of the Society, and the Council are gratified to notice that, in spite of the numerous other opportunities which are afforded for the bringing forward of subjects in which the Society of Arts is interested, the papers submitted to the Society certainly show no diminution in value, and may even be said, year by year, to become more and more important.

In accordance with the usual practice, the Chairman of the Council, Captain Douglas Galton, commenced the Session in November last with an address. The subject which Captain Galton selected was the progress which had been made in sanitation during the fifty years of her Majesty's reign. At the meeting succeeding that at which the Chairman's address was delivered, Mr. William

Anderson, in a paper on "The Purification of Water by Agitation with Iron and by Sand Filtration," described the most recent methods for the treatment of water on a large scale by means of spongy iron. Two of the other meetings before Christmas were devoted to an adjourned discussion on Dr. Meymott Tidy's paper on "Sewage Disposal," which had been read in the preceding Session. The paper, which was published in a summarised form when it was read by Dr. Tidy, was afterwards elaborated by him, and appeared at full length during the summer recess. At the remaining meeting, General Webber gave an interesting account of certain improvements which have been introduced into the manufacture of incandescent lamps. The process of manufacture, as practised by the Brush Company, was carried out in the room, several lamps being actually made on the spot. At the first meeting after Christmas, Mr. J. B. Marsh, in his paper on "Cameo-cutting as an Occupation," advocated the instruction of young women in this art, with a view to providing them with employment. The members will be glad to hear that Mr. Marsh's paper attracted much attention, and has had a practical result in the establishment of at least one class for instruction in cameo-cutting, while it has also attracted employment to some of the artists who had already received instruction from Mr. Marsh. Other papers, dealing with various branches of education, were those by Mr. Cunynghame, on "Technical Education in Elementary Schools," and by Mr. J. C. Morton, on "Agricultural Education." In a paper on "Sewage Irrigation," Dr. Alfred Carpenter carried still further the discussion of a subject which had already been partially treated in Dr. Tidy's paper, and in the discussion upon that paper; while another paper dealing with questions of health and sanitation was that by Dr. Percy Frankland, which was read at one meeting, and discussed at the meeting following.

Mr. Gordon Salamon's paper, on "Purity of Beer," derived additional interest and importance from the Bill for the regulation of the sale of beer which is now before Parliament. Mr. Salamon took rather the chemists' side of the question, and deprecated any interference with the manufacturer which would prevent the use of materials other than malt, so long as a product could be obtained indistinguishable from that derived from malt and hops alone. The subject of the cultivation of tobacco in England was brought before the Society by Mr. Beale, who gave an account of the results which had been obtained up to the present time.

Mr. W. P. Marshall's paper on "Railway Brakes" gave rise to a vigorous discussion between the advocates of the two principal systems of continuous brakes, which was afterwards continued in the *Journal*. Mr. Urquhart's paper on "Recent Advances in Sewing Machinery" had the advantage of being fully illustrated by exhibits from makers of six of the different types of machines in this country, the machines shown being driven by an electric motor deriving its current from the dynamo ordinarily employed for lighting the meeting room. In addition to General Webber's paper previously referred to, two papers were read dealing with electrical subjects. In April, Mr. Reckenzaun dealt again with the subject of electric locomotion before the Society, and at the final meeting of the Session, Mr. W. H. Preece, to whom the Society has been so frequently indebted for many excellent papers, celebrated the jubilee of telegraphy by a paper in which the advance made since Cooke and Wheatstone's instrument of 1837, up to the present date, was very fully explained and illustrated. Mrs. Ernest Hart's paper on "Cottage Industries of Ireland" gave a full account of the valuable work which has been done under Mrs. Hart's guidance in Donegal, towards providing industrial occupation for the poverty-stricken peasants there. Special interest attached to this paper, because it is so seldom that a paper has been read before the Society by a lady; the last was in 1876, by Mrs. Bladen Neill. The papers yet remaining to be mentioned are one by Mr. Traill Taylor, on "Photographic Lenses," and one by Mr. Percy Fitzgerald, on "The Machinery and Appliances used on the Stage."

II.—Indian Section.

There were seven papers read before the Indian Section of the Society during the Session. The majority of them related to the material condition of India. The opening paper was read on 21st January, when Mr. Trelawney Saunders, late an assistant in the geographical department of the India-office, and a well known authority, described "The Region of the Upper Oxus," and treated in detail the geographical features of the little known khanates of the Pamir. The second paper, read on 11th February, dealt with

"The Economical Condition of India," which furnished an excellent theme in the very competent hands of Dr. George Watt, C.I.E.; Sir George Birdwood, who was the chairman, bore testimony to the good work done by Dr. Watt for Indian interests at the Colonial and Indian Exhibition. A fortnight later, a paper treating of the desirability of greatly increased expansion of the existing railway system in India, was read by Mr. Holt S. Hallett, under the title of "The Extension of Indian Railways." Mr. Hallett's chief points were the small comparison the annual railway construction in India bears to that in the United States; the great advantage of opening a communication with China by way of Northern Burma; and the fact that there are areas in the Indian peninsula equal in size to the United Kingdom without a single mile of railway. "Our Trade-routes to the East" formed the subject of the fourth paper, in which Sir Frederic Goldsmid, well-known for his services in India and Persia, discussed the prospects of the three rival routes, those by the Cape, by the Suez Canal, and by the Euphrates Valley. The fifth paper was one on "Indian Coffee," by Mr. Frederick Clifford, who, besides being personally interested in the industry, had given special study to the subject, while the chairman, General Michael, C.S.I., a recognised authority on forestry, was able to supply some fresh particulars of its early cultivation in Southern India. The sixth paper was by Mr. J. F. Hewitt, late Chief Commissioner of Chota Nagpore, on "Village Communities in India." The seventh and closing paper of the Session was given on 27th May. Mr. J. Berry White, late Bengal Medical Service, then read an elaborate and carefully compiled essay on "Indian Tea," thus supplying a companion picture to Mr. Clifford's paper on coffee. It will be seen that four of the papers related to the products or material condition of India, while Dr. Watt treated of the subject as a whole. The attendances were up to the average, but they might well be larger, considering the importance of the topics discussed.

III.—Foreign and Colonial Section.

In consequence of the large number of subjects which were suggested by the holding of the Colonial and Indian Exhibition last year, the papers read before the Foreign and Colonial Section have, during the past Session, been wholly confined to Colonial subjects.

The Session was opened by a paper by Mr. Kerry Nicholls upon the late volcanic eruptions in New Zealand, in which he suggests some interesting theories as to their probable cause. This paper was rendered specially attractive by being supplemented with sketches taken both before and after the earthquakes, of the districts affected. Mr. Allan Ransome gave a detailed description of the results of the experiments made by him on many of the Colonial woods shown at the Exhibition, conducted with the view of ascertaining their adaptability to commercial uses. Mr. Cunliffe-Owen read a paper descriptive of the Exhibition, and of the more important products shown therein. Mr. Richard Bannister contributed a paper upon "Colonial Wines," in which striking evidences of the rapid development of this industry were given. Sir Charles Warren communicated his views on the present condition of South Africa, and on the steps which he considered it was necessary should be taken for its future development. Sir Charles Warren laid special stress upon the importance of irrigation works being undertaken in the interior of the country.

At the last meeting of the Session, Sir Augustus Adderley read a paper on the representation of "The West Indies at the Colonial and Indian Exhibition," specially dwelling upon a description of those products the trade in which is likely to be improved by having been brought prominently before the public.

IV.—Section of Applied Chemistry and Physics.

In 1874, a Section of this Society was established for the discussion of subjects connected with practical chemistry in its applications to the arts and manufactures. In 1879, the scope of the Section was enlarged, so that it might include matters connected with the application of physical science to the arts. Since its establishment, the Section has fully carried out the intentions of those who advised its formation, for it has been the means of bringing before the Society, and, through the Society, before the scientific public, many very valuable applications of science to practical purposes. Looking back at the list of papers which have been read before it, it will be seen that many of the most important of the communications to the Society during the time found a place in this Section. Since its formation, however, two independent societies, namely, the Institute of Chemistry and the Society of Chemical Industry, have been specially established for the purpose of

carrying on the work to which the Section was originally devoted; and it appeared to the Council that the Society of Arts having, as in so many other cases, originated a movement of considerable public importance, might, as the work grew, leave it in the efficient hands of the above-mentioned societies. After very careful consideration, therefore, the Council issued an announcement in October last* to the effect that they had decided to discontinue the Section, under the belief that the resources and the influence of the Society might be better applied in other directions.

V.—Section of Applied Art.

The determination of the Council to discontinue the Section of Applied Chemistry and Physics rendered it possible to carry into effect a suggestion which had often been put forward, but which, while so many of the evenings during the Session were filled up by the Society's meetings and lectures, seemed hardly practicable, namely, the establishment of a special Section for the consideration of questions of Applied Art. To aid them in carrying out their views, the Council invited the assistance of a committee including not only members of the Society, but many other gentlemen specially interested in the application of art to practical purposes. Six evenings were allotted to the Section for the holding of meetings, and through the agency of the Committee, the Council were able to secure promises of a number of interesting and valuable papers for reading at those meetings.

The opening meeting of the newly formed Section was held on Tuesday, February 1st, when Mr. T. Armstrong, Director of the Art Division of the Science and Art Department, delivered an important address on "The Condition of Applied Art in England, and the Education of the Art Workman," in which he dealt with the helps and hindrances to the progress of applied art in this country, treating chiefly of the period which has elapsed since 1864, when the late Mr. W. Burges delivered before this Society a series of Cantor lectures on "The Fine Arts Applied to Industry." This paper elicited an interesting discussion, in which lively hopes were expressed for the success of the Section. At the second meeting, Mr. J. Starkie Gardner read a valuable paper on "Wrought Iron," which was fully illustrated by drawings of historical specimens of this beautiful art in our great cathedrals and elsewhere, and by photographs of modern examples. Mr. Alfred Phillips read at the third meeting an interesting paper on the "Application of Gems to the Art of the Goldsmith," which he illustrated by the exhibition of a magnificent and most costly collection of precious stones, both set and unset. The fourth meeting was occupied by an instructive paper by Mr. Hungerford Pollen on "Ornamental Glass," in which he pointed out the true principles of art necessary in the manufacture of ornamental glass, and showed how the teachings of the earlier artists were carried out in the present day. In the paper on the "Architecture of London Streets," which Mr. E. J. Tarver read at the fifth meeting, many valuable suggestions were made as to the treatment of sites which need special attention at the present time when London is being so rapidly rebuilt. As at the first meeting Mr. Armstrong dealt with the progress of applied art, so at the last meeting the whole subject was again reviewed, and Mr. Walter Crane argued strongly for the "Importance of the Applied Arts, and their Relation to Common Life." In his paper, Mr. Crane pointed out the many hindrances which exist in our present condition of society to the progress of true art.

In response to an invitation from Professor Herkomer, some members of the Council and of the Committee of the Section visited that artist's house at Bushey, on March 18th. On this occasion Mr. Herkomer showed his visitors how the applied arts were cultivated under his direction, the whole of the woodwork, ironwork, and other decorations required for his new house being produced on the spot.

The Council are indebted to the Committee of the Section for the scheme of the Prizes for Art-Workmen, which is referred to in Section XI. of this report.

VI.—Cantor Lectures.

During the past Session, there have been five courses of Cantor lectures. The first was by Mr. Lewis F. Day on "The Principles and Practice of Ornamental Design." So far as the somewhat narrow limits of four lectures permitted, Mr. Day gave a very clear exposition of the principles which, in his view, ought to guide the ornamental artist. In the second course, on "The Diseases of Plants," Dr. Thudichum related the latest advance

* See *Journal*, Nov. 5, 1886, p. 1267.

which science has made in a very obscure and difficult subject. The third and fourth courses were both of a practical nature, one by Mr. Dent, on "Building Materials," and the other by Professor Unwin, on "Testing Machines." The concluding course was by Mr. J. M. Thomson, and dealt with the "Chemistry of Putrefaction," and with the action of substances which are used for the purpose of preventing putrefactive changes, or destroying their injurious effects upon animal health.

Dr. Bowman was announced for a course of lectures on "Textile Fibres," but he was prevented by illness from carrying out his engagement, and the course was postponed till next Session.

VII.—Juvenile Lectures.

The subject which Professor Reinold selected for the Juvenile Lectures, which the Council asked him to give, was the very suitable one of "Soap Bubbles." Professor Reinold showed that the soap bubble might be so treated as to become a valuable instrument of research, and illustrated his lectures with a great number of the very beautiful experiments to which any subject dealing with the action of light upon thin films lends itself.

VIII.—Albert Medal.

The Council believe that the members of the Society in general will have received with satisfaction the announcement that her Majesty had been pleased to accept the offer of the Albert Medal for the present year, made to her on behalf of the Council by H.R.H. the President of the Society.

In awarding the Medal to the Queen, the Council have desired to indicate, in the most striking manner within their power, the appreciation felt by the Society of the progress made during the past fifty years in those industrial arts for the promotion of which the Society was founded.

The special characteristic of the half-century during which her Majesty has reigned is certainly the application of scientific discoveries to purposes of daily life. In no similar period during the world's history has there been any such progress in those practical arts and sciences which have had so beneficial an effect on the material comfort and happiness of the human race. When she came to the throne, the first London railway was unfinished. The telegraph was a crude and doubtful experiment. No vessel had ever steamed across the Atlantic. The proposal to propel ships by screws was meeting with but little favour, and was yet practically untried. The powers of electricity for the production of light were barely known, its uses for the deposition of metals had not yet been discovered. The tinder-box had hardly been supplanted by the lucifer match. The production of pictures by light was a scientific curiosity, and the first Daguerreotype portrait had not yet been taken.

These few instances may serve merely to emphasise a fact already sufficiently well-known, that her Majesty's accession took place at a time when men were beginning to realise how numerous were the powers of nature which could be utilised for the material benefit of mankind, and when the discoveries which science had made, and was making every day, had come to be appreciated for their practical value rather than merely as additions to human knowledge. How great the progress has been, how much we are indebted to scientific discoveries for the conveniences and luxuries of modern life, there is no need to say, nor is there any need to dwell on the fact, yet more important, that these discoveries have brought such conveniences and such luxuries, formerly only obtainable by the wealthy, within the reach of people of moderate means, and have rendered life happier and pleasanter for the poor as well as for the rich.

Of the applications of science to purposes of industry during the past half-century, the greater number have originated in our own country, and it is only natural to attribute this at least in part to the government which we have enjoyed, and to the fact that the throne has been occupied by one so wise and prudent as its present holder.

And more than this. The personal inclinations of the Queen, as well as the indirect influence of the Sovereign, have contributed to the progress of our time. Her Majesty has ever been known as a judicious patron of all that has tended to the benefit of her people, and some share at least of the material progress of the country is due to the encouragement which every advance in science, every improvement in manufacture, has received from herself and from the Prince, her Consort, who for many years presided over the Society of Arts. The Council feel that the Society may fairly claim a representative position with regard to the applied arts and sciences, and they wish, by the offer of the medal, to tender one more proof to the Queen that her subjects fully

appreciate the benefits which the industrial arts have gained under her rule and from her patronage. The Council are assured, and they know that the members will agree with them, that no more fitting occasion could be chosen for the presentation of the Albert Medal to her Majesty, and that no more fitting recipient could be found for it in this present year.

High as is the estimation in which the Albert Medal has always been held, the Council are fully convinced that the fact of the Queen having accepted it this year will largely enhance its value in years to come; and that the thought that its recipients will be sharers in an honour which has not been disdained by the Sovereign, will render it even more serviceable as an incentive to workers in the future than it has been in the past.

IX.—Medals.

The Council have awarded twelve Silver Medals to the authors of papers read during the past Session. Of these, five have been for papers read at the Ordinary Meetings, two for papers read in the Indian Section, two for papers read in the Foreign and Colonial Section, and three for papers read in the Section of Applied Art.

The following is a list of the awards of the medals:—

To A. Gordon Salamon, for his paper on "Purity of Beer."

To William P. Marshall, for his paper on "Railway Brakes."

To Dr. Percy Frankland, for his paper on "The Living Organisms of the Air: the Effect of Place and Climate on their prevalence."

To A. Reckenzaun, for his paper on "Electric Locomotion."

To Mrs. Ernest Hart, for her paper on "Cottage Industries in Ireland."

To T. Armstrong, for his paper on "The Present Condition of Applied Art in England, and the Education of the Art Workman."

To J. Starkie Gardner, for his paper on "Wrought Ironwork."

To Walter Crane, for his paper on "The Importance of Applied Arts, and their Relation to Common Life."

To Allan Ransome, for his paper on "Colonial Woods."

To Richard Bannister, for his paper on "Colonial Wines."

To Dr. George Watt, C.I.E., for his paper on "The Economical Condition of India."

To Holt S. Hallett, for his paper on "New Markets and Extension of Railways in India and Burmah."

There are also two papers read by members of the Council, for which special votes of thanks were passed:—

To William Anderson, M.Inst.C.E., for his paper on "Purification of Water by Agitation with Iron and by Sand Filtration."

To William Henry Preece, F.R.S., for his paper on "Fifty Years' Progress in Telegraphy."

X.—Owen Jones Prizes.

In accordance with the usual practice, the annual award of these prizes was made to students of Schools of Art, on the results of the annual competition of the Science and Art Department. A list of the successful candidates has appeared in the *Journal*.* Six prizes have been offered for the present year, 1886-7, and the result of the competition will be published in the *Journal* as soon as the results have been received from the Science and Art Department.

XI.—Prizes for Art-Workmanship.

In 1862 the Society of Arts commenced a series of exhibitions of articles made by workmen employed in various artistic industries. Prizes varying in amount up to £600 were offered annually from 1863 to 1871 for articles shown at these exhibitions, an average amount of £232 being actually awarded in each of the nine years. The classes in which the prizes were offered included carving in various materials, artistic metal work, enamelling, painting, glass blowing and engraving, cameo-cutting, bookbinding, &c. In 1871, the first of the series of Annual International Exhibitions was held. It was considered that these Exhibitions, which were intended to be continued for ten years, and to include in succession the various industries of the country, would occupy the place of the Exhibitions of Art-Workmanship, and therefore the action of the Society in this direction was brought to an end. At the first meeting of the Committee of the Section of Applied Art the suggestion was made that the experiment of offering prizes for art-workmanship should be renewed, and, after some consideration, the Council decided to offer prizes, amounting in the aggregate to £368, in certain specified classes of Art-Workmanship. The subjects in which prizes are offered are as follows:—

* See *Journal*, September 10, 1886, p. 1017.

1. Painted glass.
2. Glass blowing in the Venetian style.
3. Enamelled jewellers' work.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving.
5. Lacquer, applied to the decoration of furniture or small objects.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration.
7. Hand-tooled bookbinding.
8. Repoussé and chased work in any metal.

The conditions under which the prizes are offered have already appeared in the *Journal*.* It may be mentioned that though the prizes will be awarded to workmen only, manufacturers may send articles in for competition; but they will be expected to give the names of all the workmen who have taken any part in the work. Articles for competition are to be sent in by the 3rd of December next, and it is intended that they should be exhibited in the Society's House some time next Session.

XII.—MOTORS FOR ELECTRIC LIGHTING.

The question of ascertaining the best motor for domestic installations for the electric light, and other similar purposes, has been for some time before the Council of the Society, and last autumn they decided to offer some Society of Arts' medals for prime movers suitable for such applications. The details of the proposed competition were carefully considered by the Committee, and, in December, the announcement was made that two gold medals would be offered for prime movers of the class referred to.† The classification was intended to include motors of every class, steam, gas, hydraulic, &c. The Council proposed to appoint three judges, who would report to the Council, and on whose report the awards would be made by the Council. The entrance fee was fixed at £2 10s. per h.p., and it was hoped that the amount derived from fees would suffice to cover a large proportion of the cost, as the Council felt that the Society could not fairly undertake the whole of the very heavy charges involved in properly carrying out tests of the nature proposed. The date fixed for sending in entries was the 28th February last. By that time a number of entries had been received, but not a sufficient number to justify the Society in incurring the necessary expense, or to make it certain that the tests would be thoroughly representative of the various types of motor. Some of the principal makers also asked that further time might be given, and on full consideration of the question, the Council decided that it would be well to postpone the trials, and they have consequently fixed a later date for the receipt of entries, namely, the end of the present year. They trust that the makers of engines in this country and abroad will be willing to take the matter up, and enable them to discover a satisfactory answer to a question which is of constantly-growing importance. The Council think it important to ascertain both the class of motor likely to be most generally serviceable, and the special motor which in each class may prove to be the best.

XIII.—COLONIAL EXHIBITION REPORTS.

In May, 1886, Sir Philip Cunliffe-Owen, the Secretary to the Royal Commission, addressed a letter to the Council of the Society of Arts, asking whether the Society would undertake to superintend the preparation and issue of a series of Reports on certain of the Colonial Sections of the Exhibition. After some correspondence as to the precise scope of the Reports, and the arrangements necessary for carrying out the proposal, the Council of the Society undertook the duty, and in a letter to Sir Philip Cunliffe-Owen, dated June 29, expressed the readiness of the Society to act.

A committee was appointed by the Council, from amongst its own members, to supervise the arrangements required for procuring and publishing the Reports.

It was decided that, having regard to the wide scope of the Exhibition, it would be desirable for the most part to confine the Reports to the consideration of the raw products exhibited, or of such manufactured products as would be likely to be of commercial importance in the trade between Great Britain and the Colonies. To this rule, however, it was found necessary to make certain exceptions. The important exhibits of machinery made by several of the Colonies appeared to call for special notice, and a report on machinery was therefore added. At the request of the High Commissioner for Canada, a report on the musical instruments shown in the Exhibition was also included.

The Council, after carefully selecting the subjects which appeared most important, and classifying them in such a manner as to secure that no important industrial products should be wholly overlooked, submitted

* See *Journal* for April 29th, p. 571.
† See *Journal*, December 17th, p. 71.

to H.R.H. the Prince of Wales a list of gentlemen whom they considered qualified to prepare the necessary Reports; and these gentlemen his Royal Highness was pleased to nominate.

The reporters were asked to send in their reports as soon after the close of the Exhibition as possible, and in most cases they had complied with this request by the end of the year 1886. In other cases, however, the tests and analyses which were required rendered necessary a slight extension of time. The volume was published in the early part of April.

A full list of the subjects of the Reports, and the names of the reporters, has already been given in the *Journal*.* The editorial work was performed with that zeal and care which invariably characterises the work of the Secretary of the Society.

The original proposal did not comprise Reports on the Indian products shown, but by the desire of the Royal Commission the Reporters on Tea, Coffee, and Tobacco were requested to include the Indian exhibits in their Reports; and in some few other cases the reporters have dealt more or less fully with Indian products.

The Council feel that they are greatly indebted to the reporters for the promptitude with which they undertook a very difficult task. and for the minute care and attention which they have, one and all, devoted to the subjects with which they have dealt. They are also glad to be able to say that the reports have been very well received by the public, and have been favourably commented on by the press. The cost of production was entirely borne by the Royal Commission, which placed at the disposal of the Society a sum sufficient to provide the fees paid to the reporters, and also undertook all charges connected with the printing and publication of the book.

XIV.—CONVERSAZIONE, 1886.

The conversazione for the session, 1885-6, was held, by permission of the Royal Commission, at the Colonial and Indian Exhibition. The arrangements which were made for it were given in the last Annual Report. These arrangements, it will be remembered, were similar to those which had been made with the Executive Councils of the Inventions and Health Exhibitions, and the financial result to the Society was the same as in the case of the 1885 conversazione, which was held at the Inventions Exhibition, since it cost the Society the amount of £300. There were 9,927 persons present, of whom 5,530 came by invitation, and 3,997 were admitted by purchased tickets. The amount received from the sale of tickets was £1,605 10s. The amount expended on bands, refreshments, garden illuminations, printing, &c., was £1,520 6s. The balance of the receipts, namely £85, together with the sum of £300 agreed to be paid by the Society, was paid over to the Secretary of the Royal Commission. Out of this sum of £385, the cost of lighting the building, together with the charges for police and attendants, were defrayed by the Royal Commission. So far as can be ascertained, the amount remaining after the payment of these charges was more than sufficient to recoup the Exhibition authorities for the loss entailed upon them by the diminution of the receipts caused by the closing of the Exhibition for the evening.

* See *Journal*, April 1st, 1887, p. 501.

XV.—CONVERSAZIONE, 1887.

The Conversazione for the present year was held at the South Kensington Museum, by permission of the Lords of the Committee of Council on Education. With the view of providing for arrangements on a slightly more liberal scale than in previous years, the Council determined to give members the option of purchasing a limited number of tickets. The number sold was 1,056, the amount received for them being £264. The total number of persons present was 3,800. The amount expended on the Conversazione was about £594, so that the actual cost to the Society will, as far as can be ascertained, be £330. These items will of course appear in the balance-sheet for next year.

XVI.—IMPERIAL INSTITUTE.

In January last H.R.H. the Prince of Wales addressed a letter to the Chairman of the Council, asking the assistance of the Society in carrying out the proposal which grew out of the Colonial and Indian Exhibition last year, for the establishment of an Imperial Institute for the United Kingdom, the Colonies, and India. The Council resolved that the best means of carrying out the desire of H.R.H. the President would be to address an appeal to the members of the Society for subscriptions to a special Society of Arts Fund for the Institute. A circular was accordingly addressed to all the members, inviting them to send in

subscriptions, or to undertake to collect contributions for the Institute. In response to this appeal, sums amounting in all to £2,289 10s. 6d. have been received; and the Council are glad to be able to inform the members that his Royal Highness has expressed himself as much gratified at the very liberal contribution which has been made by the members of the Society to the scheme in which he is so warmly interested.

The objects which the Institute was originally designed to promote were, in the words of the Prince of Wales, "the arts, manufactures, and commerce of the Queen's Colonial and Indian Empire." The further extension of the scope of the Institute, so that it may include the United Kingdom also, makes its objects absolutely identical with those at which the Society of Arts has been labouring since 1754. The scheme, therefore, cannot fail to be of the greatest interest to members of the Society of Arts, who will have the satisfaction of seeing many of the objects to which the energies of the Society have been devoted, and its limited funds applied, carried further on with the aid of the abundant resources which will be at the disposal of the Institute, and the extended influence which will be assured to it by the position of its founder, and of those that he has associated with himself in its government.

XVII.—Examinations.

The number of candidates at this year's Examinations shows a slight increase upon last year—1,232 against 1,184; in 1885 the number was 1,208. Considering that there are no other examinations quite of the same character, also that the certificates issued by the Society are of recognised value, it is perhaps remarkable that the number of entries is practically stationary. It must, however, be remembered that the grants which can be earned by teachers who train students for the Science and Art Department Examinations, or for those of the City and Guilds Institute, naturally incline them to organise classes for those rather than for the Society's Examinations. The fees charged for our Examinations also have a deterrent effect. Small as they are, however, they are not quite sufficient to cover the cost.

The importance of the study of modern languages to students of science has been recognised by the Clothworkers' Company, one of the foremost among the City Companies in the promotion of technical education, which has offered prizes, to be awarded on the results of the Society's Examinations, to the students in the textile industries or dyeing sides of the technical colleges established and endowed by that company at Leeds, Bradford, and Huddersfield.

Of the 1,232 candidates who entered 947 passed, and 285 failed. The number of papers worked was 1,315; of these, 130 took first-class certificates, 368 second-class, and 503 third-class, while to 314 papers no certificate was awarded. Ten of the twelve subjects set down for examination were taken up. In two (Political Economy, and Commercial Geography), no candidates presented themselves. In Italian the examination was held, although the requisite number of candidates (25) did not present themselves. The number of papers worked in the various subjects were:—Arithmetic, 108; English (including composition and correspondence and précis writing), 100; Book-keeping, 348; Shorthand, 323; French, 98; German, 48; Spanish, 29; Italian, 7; Domestic Economy, 58; Theory of Music, 196. The per-centage of failures in Shorthand, is very large (152 out of 323), and this may partly be accounted for by the fact that the new examiner, Mr. Reed, in accordance with a generally expressed wish, took a somewhat higher standard than his predecessor, Mr. Pitman. In reporting on the results of the examination Mr. Reed comments rather strongly on the want of preparation shown by a large proportion of the candidates. The number of entries show a considerable increase on last year, when there were 255 candidates.

It seems difficult to assign a reason for the absence of candidates in Commercial Geography and Political Economy, two subjects which are essential in commercial education, and form an important part of the course of study laid down in all foreign commercial schools. The number of candidates in modern languages is increasing, though still far short of what it ought to be. Arithmetic shows a considerable falling off (108 against 186), but the per-centage of failures is much less. Book-keeping shows an increase. Domestic Economy and English have precisely the same numbers as last year. Theory of Music attracted about the same number (196 against 194).

With a view of giving a more definite direction to the studies of the candidates, the Council requested the examiners in modern languages to select passages for translation of

a scientific, technical, or commercial character, the candidate being allowed to take his choice amongst these passages. Due notice of this was given in the Programme for the past year, and the result of the experiment has been sufficiently satisfactory.

The examiners have also been asked to prepare short notes on the papers of the past examination, in the hope that these may assist students in their preparation. These notes will be published in the Programme for next year (to be issued shortly), and also in the reprint of the papers.

XVIII.—Practical Music Examinations.

Examinations in practical music have this year been held at the London centre only. There were 188 candidates, of whom 172 passed, taking 61 first class, and 132 second class certificates; none of the candidates succeeded in taking honours. It should be stated that many of the candidates were examined both in the pianoforte and singing, and consequently the number of certificates awarded does not agree with the total number of candidates passing. A comparison with previous years shows a slight increase in the number of candidates presenting themselves, as last year there were 150, and in 1885, 181. The instruments included the piano, organ, viola, and violin. The Society is indebted to Messrs. Chappell, in this as in previous years, for the use of an organ.

XIX.—Soane Museum.

The Act of Parliament under which Sir John Soane's Museum in Lincoln's-inn-fields was established in 1833, provides that trustees should be nominated by certain bodies, of whom the Society of Arts is one. A trustee has to be elected every five years, and the period of election has again come round. Dr. B. W. Richardson has acted as the Society of Arts trustee for the past five years, and the Council recommend him for re-election. They have accordingly placed his name on the balloting list for the purpose.

XX.—Musical Pitch.

The question of a National Musical Pitch stands very much where it did when the last Annual Report was written. The action of the Society has done this much good, that it has obtained a definite statement from the highest authority,* that the War-office would offer no objection to the French pitch (A = 435 vibrations) being adopted in military bands, provided the change could be effected without the cost falling on public funds. The amount required has been estimated at £10,000. Possibly, the estimate may be found to be an excessive one, but at any rate, the expense would be too great to justify the expectation that the money would be provided either by Government or by private contributions. If, therefore, the change is made, it will probably not be effected by an alteration in the pitch of military bands, leading to a similar alteration in that of orchestras, but by a gradual change in the latter, induced by the pressure of public opinion, which may compel individual players—as suggested in the last Report of the Council—to provide themselves with the instruments required, till at last it will be found that many of the performers in the military bands are possessors of instruments of modified pitch, and the change, thus partially accomplished, can at some future time be completed without any very heavy or sudden expenditure.

* See Lord Wolseley's letter in the *Journal*, 1887, p. 572.

XXI.—Memorial Tablets.

Since the announcement in the last Annual Report, a Tablet has been set up to mark the house in Kensington-palace-green which was built by Thackeray, and in which the great novelist died. A list of the tablets previously set up to identify the houses, or the sites of the houses, in which great men have lived, will be found in the last Annual Report.*

XXII.—New Council.

The Vice-Presidents retiring this year are—Sir Robert Rawlinson, Lord Sudeley, Mr. John Walter, Mr. Edwin Chadwick, and Lord Alfred Churchill. In their place the Council propose to the Society for election—Sir Villiers Lister, The Attorney-General, Lord Thurlow, Sir Philip Cunliffe-Owen, and Sir Daniel Cooper. The first two gentlemen have served since 1883 as ordinary members of Council. Of the others, Sir Philip Cunliffe-Owen and Sir Daniel Cooper have served on the Council in former years. Lord Thurlow has not. The other two members of Council retiring are—Mr. Charles Cheston and Major-General Sir Charles Warren. To fill the vacancies thus created, the Council propose for election—Mr. E. C. Robins, Sir George Birdwood, Mr. Charles Barry, and Mr. James Grierson. Of

*See *Journal*, July 2, 1886, p 861.

these, only Sir George Birdwood has held office previously.

XXIII.—List of Members.

The total number of life members, subscribing members, and institutions in union which subscribe to the Society from their own funds, is now 3,569. It is to be regretted that the numbers show a slight falling off from last year, when they were was 3,657. During the year 1886-7, 362 members have been removed from the list by death or resignation. During the same period, 274 have been elected.

XXIV.—Obituary.

In no recent year has the Society had to deplore the loss of so many of those who have been active workers on its behalf, or closely associated with its proceedings. Dr. Mann, who had been for many years the energetic Secretary of the Foreign and Colonial Section, died very soon after his election on the Council last year. Other members who had served at different times upon the Council, were Mr. Cassels, Col. A. A. Croll, Sir Douglas Forsyth, Mr. E. C. Tufnell, and Sir Joseph Whitworth. Lord Henry Lennox was for many years its Chairman, and Mr. Francis Fuller was (in 1850) elected to that office, though he only held it for a few months. Dr. Guthrie and Professor Barff gave valuable series of Cantor lectures before the Society, and the latter also contributed several papers. Sir W. P. Andrew, Admiral Bedford Pim, Mr. Rimmel, and Mr. James Gibbs, had all read papers, and papers of importance, before the Society. Sir John Anderson was, in years past, one of the Society's examiners, and Mr. Pitman filled a similar post at the time of his death. Captain Eads was the holder of an Albert Medal, and Dr. Norman Chevers had received a Swiney prize. Other notable names which have been removed by death from the list of members are those of Sir Francis Bolton, Mr. Samuel Morley, Mr. George Clowes, and Sir John Kelk. Notices of all these, and of other members who died during the year, will be found in the columns of the Society's *Journal*.

XXV.—Finance.

According to the provisions in the bye-laws, the Statement of Receipts, Payments, and Expenditure for the past financial year of the Society, ending May 31st, 1887, was published in the last number of the Society's *Journal*. There does not appear to be much in the Statement which calls for explanation. The main source of the Society's revenue, the annual subscriptions, shows a slight falling off from last year, the amount being £6,270; last year the corresponding amount was £6,500. The amount paid for life compositions, however, is greater, being £567 as compared with £451. The sum of £500 provided by the Royal Commission for the Colonial and Indian Exhibition, was, as shown on the other side of the account, nearly all expended on the Reports, the small balance of £8 15s. being returned to the Commission. With the exception of some small petty cash expenses, this was all paid in fees to the authors of the reports.

The current items of expenditure show but little variation from the corresponding items in previous years. The large amount expended on the 1886 Conversazione, £1,905, was to a great extent met by the receipts from the sale of tickets, £1,605. Besides the life compositions, £1,014 has been invested, and, in addition to this, the £109 standing to the credit of the Mulready Trust was sold out of India Four per Cent. Stock, in consequence of notice being received from the India Government that this stock would be paid off next year, and was re-invested in South Australian Stock. As the lease of the Society's premises will expire in 1897, the Council believe that the members will approve of their making provision for any outlay that may be required, by funding the surplus of each year's income.

The liabilities of the Society are a little lower than last year. The assets, in consequence of the investments which have been made during the past year, are higher. The excess of assets over liabilities is now more than £14,500. The invested funds of the Society amount to a little over £10,500. The trust funds standing in the Society's name amount to £14,053.

The Chairman, in moving the adoption of the Council's Report, expressed his conviction that the members would all agree with him that the Society was in a most satisfactory condition, and that its influence was increasing year by year. He also referred to the paragraph in the Report which related to the preparation of the series of Reports on the Colonial and Indian Exhibition, and added that this paragraph was specially inserted by the Council, as a testimony to the way in which the editorial work in connection with these Reports had been performed by the Secretary.

Mr. E. C. Robins seconded the motion, and touched upon the increasing applications of science

to the welfare of mankind, which it was the Society's peculiar province to encourage.

Mr. THOMAS HILTON, after some remarks upon the financial statement in the Report, and upon the unadvisability of inserting as assets particulars of the lease, and the pictures, &c., which the Society was not likely to sell, alluded to the sale of tickets for the Conversazione, and advocated the discontinuance of this practice in future, and the free distribution of complimentary invitations.

Mr. P. L. SIMMONDS, who said he spoke as having had a considerable experience of such matters, as a member not only of the Society of Arts but of several other societies, thought there would be great difficulty in issuing an unlimited supply of free tickets to the Conversazioni, and that the system of sale was a necessary one, as a check upon the expenditure.

Mr. P. S. REID proposed a motion to the effect that the Council should take into early consideration the position of the Society's lease, and appoint a committee to report thereon. He commented upon the short period remaining of the lease, and thought the Society should, in view of its expiry, begin to set their house in order.

Mr. HYDE CLARKE, while thinking that Mr. Reid's motion could scarcely be brought forward in regular form at that time, agreed with him that the matter of the Society's lease was a very important one, and he thought it a matter of gratification that a considerable addition had, in view of the near future, been made of late years to the funded property of the Society. At the same time, he deprecated the putting forward any motion on the subject, as the Council might be trusted to give the matter the most careful consideration.

The CHAIRMAN explained that Mr. Reid's motion could not be formally brought before the meeting, but he assured the members that the Council would take the matter of the lease in hand. He also said that the subject of the sale of conversazione tickets should receive the attention of the Council, but that the existing arrangements had been adopted after very careful consideration.

Sir HENRY DOULTON said that a few years ago he was a member of a committee which considered this question of the renewal of the lease, but it was then thought that time had not come for the Council to take action.

Mr. T. H. BLAKESLEY referred to the discontinuance of the Section of Applied Chemistry and Physics, and asked whether it was to be permanently abolished.

Mr. LASCELLES-SCOTT advocated the reduction of the fees for the motors for electric lighting competition, as he considered them likely to prevent entries, and he thought any deficiency likely to occur could be made up in some other way.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.	Prof. James Dewar, M.A., F.R.S.
H.R.H. Prince Albert Victor of Wales, K.G.	Colonel J. F. D. Donnelly, R.E., C.B.
Sir Frederick Abel, C.B., D.C.L., F.R.S.	Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
Duke of Abercorn, C.B.	Sir Frederick Leighton, Bart., P.R.A.
The Attorney-General, M.P.	*Sir Villiers Lister, K.C.M.G.*
Sir Edward Birkbeck, Bart., M.P.	Duke of Manchester, K.P.
Sir Frederick Bramwell, D.C.L., F.R.S.	George Matthey, F.R.S.
Sir Daniel Cooper, Bart., K.C.M.G.	General The Right Hon. Sir Henry F. Ponsonby, G.C.B.
Alfred Carpmael.	William Henry Preece, F.R.S.
T. Russell Crampton.	Owen Roberts, M.A., F.S.A.
Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E.	*Lord Thurlow.*

ORDINARY MEMBERS OF COUNCIL.

William Anderson.	Sir Henry Doulton.
William Henry Barlow, F.R.S.	R. Brudenell Carter, F.R.C.S.
Charles Barry, F.S.A.	*James Grierson.*
Sir Francis Dillon Bell, K.C.M.G., C.B.	Lieut.-Colonel A. C. Hamilton, R.E.
Sir George Birdwood, M.D., LL.D., K.C.I.E., C.S.I.	*E. C. Robins, F.S.A.*
Sir Juland Danvers, K.C.S.I.	Sir Saul Samuel, K.C.M.G., C.B.

TREASURERS.

B. Francis Cobb.	William Rolle Malcolm.

SOANE TRUSTEE.

B. W. Richardson, M.A., M.D., F.R.S.

SECRETARY.

H. Trueman Wood, M.A.

The CHAIRMAN moved the usual vote of thanks to the Scrutineers, which was carried unanimously.

Mr. HYDE CLARKE, in proposing a vote of thanks to the Chairman and the Council, said it must be a matter for congratulation to the Society that her Majesty had conferred upon the Chairman an honour which had long been foreseen for him. In heartily congratulating Sir Douglas Galton, he hoped it might be considered that the distinction had been conferred upon him not only in recognition of his public services, but also in his capacity as Chairman of the Society of Arts.

Mr. LASCELLES-SCOTT seconded the vote, and referred to the honour recently bestowed upon Sir Henry Doulton.

The CHAIRMAN, in returning thanks, mentioned that beside the honour the Society had received through members of its Council, to which reference had been made, honours had also been conferred during the present year upon three recipients of the Albert Medal, viz., Sir William Armstrong, Sir Joseph Cunliffe-Lister, and Sir Henry Doulton.

The CHAIRMAN moved a vote of thanks to the Secretary and other officers of the Society. This was seconded by Mr. OWEN ROBERTS, and carried. The compliment was acknowledged by the SECRETARY.

Correspondence.

COMMERCIAL EDUCATION.

At the close of this Session, and in view of an important meeting at the Society's House, July 1st, for the Promotion of Technical and Commercial Education especially, may I, as an old member of the Society and one of your body of examiners, point out a few of the difficulties that appear to me to retard the progress of higher commercial instruction throughout the empire?

I venture on such a step, unasked and unauthorised—because the experience of every member may become useful perhaps in so far as it relates to the wants and wishes, or even to the indifference, of both employers and employed in the commercial world; and also, because it may prove serviceable to the Directors of the new Imperial Institute, in their efforts to crown, or continue, or supplement—no matter which—the labours of our Foreign and Colonial or of our Indian Section. The foundations laid by our forefathers in 1754—and enlarged in 1847—have already served for several superstructures.

I propose to submit a short account of the origin of public instruction in commerce abroad; as well as refer to queries addressed to me by earnest correspondents—and this, not to stop further inquiry, but to stimulate independent research.

Indifference is the greatest difficulty; and misapprehension of our true position causes it. Many say, "Why should commerce be generally or even widely studied, when it concerns the mercantile part of the community only?"

The mercantile part is the larger and more important one, and the principles of exchange affect every part of the community. Agriculture will not suffice for a growing population like ours; the best resource now is the deck of a merchantman, or a desk on 'Change.

Seven hundred individuals leave our country every day, literally to "seek their fortunes;" and how are they prepared for the task? Even after their departure,* eleven hundred others, strangers, need providing for. Of the two great factors of wealth—materials and intelligence—the latter only can be multiplied and made common property; happily it is the more valuable. On this head Mr. Robert Mallet said, after the International Exhibition of 1862:—"In the absence of the sovereign gifts of natural wealth, prosperity, comfort, and power may, by seeking and employing artificially-made channels of industry, be largely developed. Thus it was with the Dutch, once prayed for in English liturgies as 'the poor and distressed States of Holland,' with a bleak and damp climate, and a sterile soil presenting nothing but a flooded bed of sand and silt, who achieved, in the teeth of every disadvantage, the highest mercantile prosperity, a paramount maritime prowess, and became the founders of great and distant colonies."

Insular prejudice prompts many others to say: "Because our neighbours chose to go to school to learn business, need we do the same?" Why do they do it?

In comparing ourselves with others, we must remember that a century ago, the introduction of steam-power gave to England a preponderating advantage. Our possession of beds of coal and of iron ore promised to secure that; but the rest of the world thought it desirable and possible to find in the more genial diffusion of mental power a countervailing agency to our increased material force. Continental philanthropists and patriots urged that "the mind of a nation is more valuable than its soil." States welcomed the idea with enthusiasm. Humboldt and kindred spirits were appointed ministers of public instruction. Chosen bands—nay battalions, of teachers were enrolled, and disciplined to do the State the noblest service. It was never supposed that the general ability and the good will of an operative could be multiplied or intensified like

* The surplus of births over deaths in United Kingdom, says Mr. Mulhall, is 1,500 daily; and to these must be added the arrivals of about 300 foreigners and colonials.

the leverage and the steam-power of an engine—the contrary was felt; and a science of education arose, as a result of the study of the human being to be educated, no less than of the departments of human knowledge—yet, out of that study came many divisions and subdivisions of instruction both in universities and in polytechnic institutions.

"But what," it is continued, "can be learned of commerce in schools, or anywhere out of a counting-house?"

The reply is clear. A counting-house is a place in which commercial knowledge must be used rather than sought. Abroad, a youth at school studies the sources of supply for the goods he must hereafter deal in. There he is made acquainted with the laws and conditions of soil and climate, and afterwards brought into contact with specimens of produce in trade-museums, from different trade areas; these he is required to examine and describe methodically. He is habituated to scientific nomenclature, which is suggestive not merely of the natural relationship among things, but of their chemical composition and valuable properties. He learns the "natural" in contradistinction to the "national" divisions of commerce; the resources of countries, rather than the names of their ruling powers. He studies the progress of the useful arts everywhere; the growth and vicissitudes of commerce in all ages. From the outset he is entitled to a kind and degree of intellectual discipline that must beneficially affect him.

Inquiry is further made, "Whether Continental Trade-schools are in any way connected with the old guilds, or with the Government?" Not necessarily with either! Influential merchants and manufacturers, foreseeing the effect of the dissolution of the guilds, and of the adoption of "free industry," with its irresponsible action among capitalists, as well as its uncontrollable combinations among operatives, bethought them of higher culture as the best means of promoting a good understanding among all parties. "Let us establish," said they, "by the side of the universities, polytechnic schools, and technological institutes. Let us, by means of art galleries, drawing schools, apprenticeship schools, continuation schools, trade schools, and trade museums, bring the means of living more into harmony with the great ends and aims of life. Let us train head, heart, and hand together. To the study of the word let us add the works of God."

No opposition was raised, and there was virtually no attempt made to retain the monopoly of the ancient guilds, or to resuscitate a single league; yet the discipline that had marked tham all, their love of excellence, and their allegiance were reverently preserved.* It was felt that in most departments of industry, except agriculture, "there was periodically a want of some renovating and regulating power."

Government aid was invoked only for inspection and approbation. Here and there schools of commerce were warmly encouraged by dispensations from military service in favour of exemplary students.*

Next, it has been asked, "Whether there is any novelty or speciality in the Continental preparation for business?"

Nothing, known to me! The canons of instruction in commerce, I incline to think, comprise something like the following, for ground-work:—

It has been observed that certain modes of procedure in business recur from generation to generation. These are the unwritten laws—the prescriptive usages of trade—to be learned, and understood.

In all transactions, mercantile or otherwise, there is a safe course and an unsafe one, a right course and a wrong one. It is important to adopt the former and avoid the latter.

Good fortune or the reverse cannot be a matter of indifference; but in business we must trust nothing to luck or chance.

For each legitimate calling there must be due preparation, and for permanence, organisation; to ensure excellence on the one hand, and to remedy the effects of illegitimate trading on the other.

Every calling in life relates to the mind or the body. Commerce is concerned chiefly with material necessities; and commercial men are rather men of action than theorists. All theories and speculations need practical tests. "As the downward curve of a rocket, or the fall of a spray in a fountain, is caused by gravitation, so all flights of fancy or mere surmises, must be subdued by what Bacon calls the wisdom of business."

Where that wisdom of business prevails, commercial pursuits are assuredly not soul-debasing, or injurious in any sense to any body. There should be no conflict or contempt between merchants and men of learning; for in their highest development they approach each other, like the opposite sides of a pyramid, and culminate in the character of the statesman, the consul, or the president of a chamber of commerce.

I have very often been asked, "Why is commerce called a science?" Why do the French write "les Sciences du Commerce"?

Commerce is a compound word, from *commutatio mercium*, meaning "the exchange of merchandise," which must be all drawn from one of the three kingdoms of nature. It may be "raw produce," as drugs, gems, minerals, wildfowl, fish, &c., or manufactured commodities. Exchange itself is necessitated by the structure of the globe. *Non omnis fert omnia*

* For details of the transition, see "Zschokke's Labour stands on Golden Feet," caps. xix. and xx. G. Philip and Son. For practical measures, see "Das Gewerbewesen im Königreiche Bayern, diesseits des Rheins," Munchen, 1859. Or, "Ein gewerbliches Fragenbuch," by Dr. Karl Karmarsch, 1877. See also "Technical Training," by T. Twining, Twickenham. "Education, Scientific and Technical," by Professor Robert Galloway. London: Trübner and Co.

* Rothschild's "Taschenbuch für Kaufleute," p. 4.

tellus. It is a characteristic of humanity, and underlies civilisation. "Man alone balances, yet deepens our mutual independence by the arts of exchange."

Science has been defined, "Knowledge of natural laws derived from a knowledge of facts." Theologically expressed, science is simply man's knowledge of God's ways, which are unalterable, yet mercifully discernible. Thus, while we may smile at the expression "Science of Commerce," it nevertheless begins and ends in a study of nature, and no competent judge donbts the soundness of principles so based. Nor, can any sane man see our supremacy in manufacture and trade challenged in all markets, and our goods, as well as our aspirants for mercantile employment at home, beaten by Dutchmen and Germans without admitting that there must be something of value in the kind of training which accomplishes such things.

What does the "Science of Commerce" comprise in its entirety?

It comprises an acquaintance with commercial history and geography; social and political economy; mercantile occupations; goods, in all varieties; currencies, weights, and measures; bullion and exchanges; transit and transport; insurance and securities of all sorts; consular duties; chambers of commerce, &c.

A good commercial man must be an adept in correspondence in several languages, general commercial law, accounts, usages in different countries, international obligations, and means of communication.

Why should commerce be generally taught?

Because without commerce industry must be intermittent; crops would not be raised unless a market could be found for them; our farms and our plantations might all be abandoned. Again, of two spots equally favoured by nature, if one be cultivated and the other not, which redounds most to the credit of human nature and to the glory of God? What else than culture can lead to the full appreciation of the "earth-gifts" of Divine Providence, and qualify us to appropriate them everywhere? How else is "the field to become a fruitful garden, and the wilderness to blossom as the rose?"

In 1878, I ventured to say:—"By higher commercial education I do not mean that which leads a youth to look merely for a higher rate of interest on capital, or of profit in business, but that which trains him to appreciate fully the objects, advantages, and pleasures of a commercial calling. Such an education would fit him to compete with all comers; to be prepared to keep faith with everybody; to value justly whatever is valuable; but not to expect uniformity of weight, measure, custom, or opinion throughout the world."

The question has sometimes been asked—Might not the training of an industrial "university" be prejudicial to business-energy and enterprise?

I answer, No! it would promote both! Most likely it would rouse the latent ambition of a youth; it would go far to preserve that integrity of soul which scorns a mean action, which maintains credit intact all over the globe, which upholds international morality, law, and liberty. Further—extended and more elevated culture in commercial colleges would promote greater energy and enterprise. It would, as nothing else could, make young men acquainted with the different regions of the globe; it would show the prospects of trade, where industry is rising, where falling, and why. By educating young men together it would raise them, as it were, from the level of solitary anglers to that of systematic fishermen; it would lead them from dreaming of baits and hooks only, to the study of supply and demand, together with all the sciences of commerce.

In manufacture we have advanced from simple tools to combinations of them in machinery; and so in commerce, we have passed from the scope of individual aptitudes to the range of co-operative intelligence.

JOHN YEATS.

Chepstow, June, 1887.

CAOUTCHOUC YIELDING PLANTS.

I gather from Mr. Jackson's remarks, in page 772 of this *Journal*, under the above heading, that the authorities at Kew Gardens are taking an interest in this and similar matters. I was not aware of this when my notes were put together, so that I hope this explanation will dispel any idea (if such has arisen) of disrespectful feeling towards Kew.

With reference to Mr. Jackson's remarks on the *Mangifera indica* and the Mangabeira (*Hancornia speciosa*) which latter yields Pernambuco rubber, I may mention that when I was in Pernambuco a few years ago, I pointed out to a gentleman that the Mangabeira was an important rubber tree, and he remarked that "even if it were found to yield india-rubber, the tree was too valuable for its fruit to work on it for india-rubber."

The *Mangifera indica* (Anacardiaceæ), Mr. Jackson says, is the mango tree of India. The Mangabeira (*Hancornia speciosa*) is the mango tree of Pernambuco. In suggesting that there might be a similarity in these plants, I was guided by the etymology of the names. We know that the action of the muscles concerned in utterance varies, especially in languages belonging to the Latin family; labial sounds are frequently transferred or blended into dentals, gutturals into palatals, and *vice versâ*, so that a modest stretch of the imagination might have led any one to call these plants mango-bearing trees. In languages belonging to the Indo-European group this interchange is perceptible but not so distinct.

It is a fact that Ceara rubber comes to hand in the form of masses made up of "tears," which would lead one to believe that the tree is punctured; when the sap exudes and dries up, probably closing the

puncture; on removal of the tear a fresh exudation takes place.

I have not witnessed the collection of rubber at Ceara, but I mention this merely to show that it is a very different product from what we know as Pernambuco rubber. Since reading Mr. Jackson's notes, I have referred to a work on Brazil by Agassiz and his companions, in which an extract appears from Gardner's "Geological Notes." Gardner says "that a species of Caryoca, called pike, a small tree belonging to the natural order Apocynaceæ, which produces a delicious fruit called *Mangaba*, is cultivated at Ceara."

It was this which led me to say this plant was the same as the rubber-producing tree of Pernambuco, but it was clearly a mistake to give it as the source of Ceara rubber, although, in fact, Pernambuco rubber is met with in commerce under the name of this place or province, and Mangabeira rubber is met with in commerce under this distinctive name.

There is a singular confusion in Gardner's notes, which perhaps Mr. Jackson will kindly explain. As far as I can see, the Caryoca does not belong to the Apocynaceæ, but to the Esculaceæ. It seems to me that this is an important matter, and deserves clearing up, for if it turns out to belong to the Apocynaceæ, it is probably a rubber-producing tree. There is a strong probability of its being identical with the Pernambuco tree.

Mr. Jackson's remarks as to the Chicoraceæ would lead one to believe that because the dried juice of the dandelion and allied plants is inelastic, it does not contain caoutchouc.

I give here a translation from the *Moniteur Officiel* (Feb., 1887), respecting the extraction of caoutchouc from the *Sonchus oleraceus*. The process here given is pretty much the same which I have employed for the examination of milky juices for the last twenty-five years, and I can therefore add my testimony to its value. The main difference is that I have worked on the expressed juices of the fresh plant, whereas in this treatment the plant itself is used.

"To extract caoutchouc from this plant (*Sonchus oleraceus*), the plant is exhausted with bisulphide carbon, and the residue left on evaporation of the bisulphide is treated with boiling alcohol. The insoluble matter, which is crude caoutchouc, is warmed with an alcoholic solution of potash, and washed repeatedly with warm, weak alcohol.

"By this treatment fatty matters and wax, as well as chlorophyl, are removed. The residue is elastic, and strongly coloured, it presents all the properties of caoutchouc, dissolving entirely in chloroform, and bisulphide carbon, and partly in ether. We obtain 4·13 per cent. extractive matter, ·41 crude caoutchouc, which gives ·16 when purified.

"The plant may be exhausted with benzine after previous treatment with alcohol; the residue, on evaporation of the benzine, gives 92 per cent. of the weight of the plant; which by treatment with alcohol gives ·27 per cent. caoutchouc nearly pure."

Of course in a warm climate these volatile solvents could not be used, but if we wish to know whether a plant contains caoutchouc, this process may be simplified. There is evidently a very erroneous method in use for precipitating these juices by alcohol, the result being that we get all the gum, mucilage, more or less extractive matter, hydrated resins, &c., all mixed with the caoutchouc if present. On a future occasion I hope to deal with the chemical treatment of these juices.

THOMAS T. P. BRUCE WARREN.

General Notes.

COMPENSATION FOR INJURIES TO WORKMEN.—At a recent meeting in Berlin of surgeons attached to railway workshops, a scale of unfitness for work was drawn up. A standard of 100 per cent. was agreed to as representing the loss of both eyes, both arms or hands, both legs or feet, and one arm or hand, and one foot. The remaining possible injuries were classified as follows:—Right hand, 60 per cent; one foot, 50 per cent.; left hand, 40 per cent.; right thumb, $33\frac{1}{3}$ per cent.; one eye, 22 per cent.; left thumb, 14 per cent.; first finger of right hand, 14 per cent.; first finger of left hand, 8 per cent.; any other finger of right hand, 6 per cent.; any other finger of left hand, 4 per cent. It is remarked by the *Colorist*, of Vienna, that the valuation of the right thumb at $11\frac{1}{3}$ per cent. more than one eye is curious.

NATIONAL ASSOCIATION FOR THE PROMOTION OF TECHNICAL AND COMMERCIAL EDUCATION.—The inaugural meeting of this Association is to be held in the rooms of the Society of Arts, to-day, at 12 noon, with the Marquis of Hartington in the chair. At a preliminary meeting held at the House of Commons, on June 13th, the following, amongst other subjects, were suggested as matters with which the Association may concern itself:—1. The co-ordination of the technical education of the country in accordance with the needs of the various classes of employers and employed. 2. The foundation of a Board of Advice and Recommendation. 3. The spread of information as to the progress of technical education both at home and abroad. 4. The adaptation of schools to the industrial requirements of the several necessities of the working classes. 5. The removal of legislative disabilities, and the support of measures for the promotion of technical education in all its branches. The circular, calling the meeting, is signed by Sir Henry E. Roscoe, M.P., and Mr. Arthur H. D. Acland, M.P.

Journal of the Society of Arts.

No. 1,807. Vol. XXXV.

FRIDAY, JULY 8, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen under the following classes:—

1. Prizes are offered to Art-workmen in certain classes of Art-workmanship enumerated below. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—

(i.) Copies of existing works.
(ii.) Modifications of existing works.
(iii.) Original works.

4. In awarding the prizes, the judges will take into account the following points:—

1. Originality or beauty of design.
2. Fitness of treatment.
3. Excellence of workmanship.

5. Before the award of prizes is finally made the candidates must be prepared, if called upon, to satisfy the Council of their competency.

6. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

7. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for any accident or damage of any kind.

8. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

9. All the prizes are open to male and female competitors on equal terms.

10. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

11. All articles for competition must be sent in to the Society's House on or before Saturday, 3rd December, 1887, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope giving the name and address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House, or, if the necessary arrangements can be made, at the South Kensington Museum.

12. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the discretion of the judges.

Prizes are offered in the following eight classes for the present year as follows:—

1. Painted glass, £25, £15, £10.*
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other

* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

material, with or without engraving, £25, £15, £10.

5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.

6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.*

7. Hand-tooled Bookbinding, £25, £15, £10.

8. Repoussé and chased work in any metal, £25, £15, £10.

Proceedings of the Society.

CANTOR LECTURES.

MACHINES FOR TESTING MATERIALS, ESPECIALLY IRON AND STEEL.

By Prof. W. C. Unwin, F.R.S., M.I.C.E.

Lecture I.—Delivered March 21st, 1887.

I imagine it is rather the object of Cantor lectures not so much to convey novel information as to put clearly the knowledge which an expert acquires in some particular department, and which is perfectly well known to those who like himself have been engaged in that particular branch of investigation.

In every work of construction, from the earliest times, some attention must have been paid to the selection of material, the proportioning of material, and the arrangement of material, to obtain the greatest strength with the greatest economy of expenditure. It is, however, under the pressure of modern necessities that the problem of using materials to the greatest advantage in securing strength has come to be before all other considerations in the mind of the designer. In modern structures, whatever other objects are in view, the designer has always to consider what are the straining actions to which the structure will be subjected, and what is the safest material to use, and the best disposition of it, and the least amount of it necessary to resist the straining actions. The cause may be the increased value of materials, or the greater use in construction of manufactured materials, or the greater scale of modern works, or the commercial conditions under which they are executed, but whatever the cause is, the modern engineer or constructor has to consider what is the least amount of material required to provide adequate strength.

Now, the simplest way of ascertaining the safety of a structure, say a railway bar or a bridge, is to apply to it a testing load greater than the maximum load to which it is likely to be subjected. To a certain extent this testing of a completed structure is, and always will be, resorted to. Before a boiler is put under steam, it is tested by hydraulic pressure. Before the ordinary traffic passes over a railway bridge, a heavy testing load is placed on it. Such tests sometimes reveal defects, but it would be extremely inconvenient to erect structures with a chance that they would break down under the testing load, and such tests of completed structures have become, to a certain extent, superfluous; they are useful as affording a final guarantee of security, but do not supply very important or very specific information. In by far the larger number of cases no testing load can be applied, except the ordinary working load, after the structure is completed. It is here that purely theoretical studies come to the assistance of the engineer, for the materials he uses, the deformations due to stresses are small, and, within working limits of stress, the strains are nearly proportional to the stresses. It is possible to reduce the straining actions in the most complex structure to comparatively simple straining actions in their separate members. With the part of applied mechanics which deals with the determination of simpler straining actions on the members of complex structures we have not, in these lectures, to deal. Supposing, however, this reduction made, then experiments on pieces of material subjected to simple straining actions will show how the members of complex structures should be proportioned, and hence, for 100 years or more, engineers have been constantly experimenting on small pieces of different material subjected to simple straining actions. Experiments of this kind are called tests of the strength of material, and machines for making these tests are called testing machines.

There are two distinct objects in view in subjecting materials to mechanical tests; one is a scientific object, and the other is a commercial object. When the object is scientific, the experimenter aims at a determination of the physical constants of the material—at verifying the assumptions on

* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

which theoretical calculations are founded. When the object is commercial, the experimenter has in view to ascertain whether samples of material comply with certain more or less arbitrarily chosen standards of quality; and the fact that the methods of scientific testing and commercial testing more or less coincide should not be allowed to obscure the fact that there is an essential difference between them. In scientific testing we seek absolute results. We ask what is the elastic limit, and the modulus of elasticity of a material and so on? In commercial testing we require only comparative results; we want to know which of the two samples is the better for a given purpose.

First of all, a word about the objects in view in scientific testing. The data most important to ascertain for scientific purposes are these. We require to determine the density of a material. In most cases, in engineering structures a large part of the straining action is due to the weight of the structure itself, and depends on its heaviness; and at all events, in contracts, the weight of a structure has to be taken notice of, so that the density of a material is the first constant we require to determine. Next, there are certain co-efficients of elasticity. A structure must be so designed that not only does it resist the force to which it is subjected without breaking down, but it is also necessary that it should not be sensibly deformed. A tie elongates when loaded, a girder deflects, and it is necessary that this elongation should not exceed certain limits. The coefficients of elasticity express the straining actions and deformations. In certain cases, the stresses in a structure depend on the deformations, and the coefficients of elasticity enter into the equation for determining the stresses.

The third kind of constant which we require in scientific testing is what are termed the limits of elasticity. They are the limits beyond which all the formulæ used in determining the stresses cease to apply, and, so far as we know, they are also the limits of safety. Now there are some materials which, in their initial condition, are for no range of stress perfectly elastic. Cast iron is not initially perfectly elastic for any range of stress; but with many materials, and with most materials that the engineer uses, after they have been subjected to a certain amount of loading, the material is what is termed perfectly elastic, at least for some range of stress. For some range of stress the deformations and the stresses are exactly proportional. Beyond that range of stress permanent alterations of a not perfectly understood kind occur; the material takes a permanent set, and those alterations or sets, however individually minute, accumulate in certain conditions, and on repetition of the loading, and ultimately cause fracture. I shall speak of this action a little more fully, but at the present instant I mention that the objects of scientific testing are to determine the limit of elasticity in the initial condition of the material, and in the condition to which it is reduced by the action of the loading.

Then a fourth constant which we require to determine is the breaking stress of a bar. The load which causes fracture with any given kind of stress is very easily determined, and in a certain sense it is a perfectly definite constant for the material. The testing is done under definite chosen conditions. So far the breaking stress may be regarded as one of the physical constants which it is the object of scientific testing to determine. I shall speak by-and-bye of the sense in which the breaking stress so often appealed to is not so stable and fixed a constant for material as it is commonly supposed to be. At any rate the breaking stress is very commonly used as the most easily ascertained, and the most convenient index of the relative value of similar materials.

So far for the objects of purely scientific testing. The materials used by engineers are natural or manufactured products, and generally there are several sources of supply available to the engineer. The engineer requires to be able to distinguish between the quality of materials coming from different localities or different manufactories. This is especially the case with manufactured products which differ materially in quality and cost. The manufacturer may be skilful or careless, he may use good or bad raw material, or accidental circumstances may interfere with the process of manufacture. The conditions involved in the success of a manufacture are numerous and complex, and no mere supervision of processes, or examination of the resulting product, is an adequate guarantee of quality. The engineer requires to know if he has got good material, or at least material good of its kind, and suitable for the purpose intended. For determining this, no method is so convenient or safe as the selection of portions of material, which are then subjected to appropriate tests, and they are compared with a more or less arbitrary standard which

may happen to be selected. Tests of this kind we call qualitative or comparative, and this is the character of what may be termed commercial testing, without any intention to depreciate its importance.

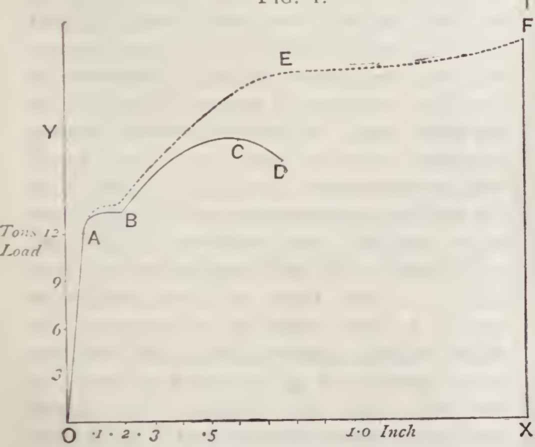
Now let me say a word about the physical conditions in which we find materials. In the first place, I have already mentioned that, for a certain range of stress, most suitable materials are perfectly elastic. The most ordinarily observed character of a material which is perfectly elastic is that the deformations are proportional to the stresses. It is a corollary of that, that a perfectly elastic material, after a load has been placed on it and taken off, returns to its primitive condition. Now the physicists who studied early the characteristics of materials insisted very strongly, and very rightly no doubt, that if you had a material which, after loading, returned absolutely to its primitive condition, it was not hurt by the loading, but you might repeat the load as often as you pleased. As to what happened to a material which did not return to its primitive condition, it is obvious that we cannot be so clear. If, when you put the load on a material, it takes a permanent alteration or set, the material itself has been altered; and if that set is repeated every time it is loaded, it is obvious that ultimately the material must break down, however small the individual sets may be. I do not know that physicists have been very positive what would happen when you went beyond the limit of elasticity, but they were quite sure that up to the limit of elasticity you were quite safe in loading the materials.

Now there is another kind of condition in which we find materials, which we call the plastic condition. A perfectly plastic material is a material which, under the action of any stress whatever, however small, will go on suffering deformation. The simplest case of a plastic material is, perhaps, a stick of sealing-wax, which, even under the action of its own weight, will gradually and slowly bend down. Now it is obvious that with a perfectly plastic material no stress is permanently safe. A plastic material is not safe for any range of stress, supposing the stress to be continued long enough, or to be repeated often enough. It must break down ultimately, if the repetitions are sufficiently numerous. If we examine ordinary materials like iron and steel, we find that they pass from a perfectly elastic stage, in which we find them for moderate stresses, through a period in which they show partly elastic and partly plastic properties, and reach at last a condition in which they are perfectly plastic, and the point is to determine at what stage between the elastic limit and the ultimately perfectly plastic stage, and before the plastic stage is reached, the material is safe; and it is that limit for any given condition of straining action which determines the constructional value of the material. I touch very lightly on this. What seems to be the case about those materials which we ordinarily use is this—with ordinary material like iron and steel, for instance, the elastic limit is not a fixed one, but can be raised or lowered by the treatment to which the material is subjected. Under certain conditions, the elastic limit may be raised very nearly to the breaking point. The question arises, therefore, whether when an elastic limit has been raised by loading the material has become safe up to that new elastic limit for any duration and variation of subsequent loading. A bar strained in tension to nine-tenths of the breaking weight may have an elastic limit in tension which is much higher than its primitive limit. Has it been improved by the process, and rendered safe for a greater range of loading? Probably for a permanent tensile stress it is safe up to the new elastic limit: but for conditions of varying stress, for loading and unloading, and still more for alternating stresses in opposite directions, things happen somewhat differently. It appears to be clear now, that though you can raise the elastic limit of a material in one direction, you do it at the expense of its elastic limit in the opposite direction. If you raise its elastic limit for tension, you lower the elastic limit for compression, and for any given material there is only a certain range of variation of stress for which the material can have perfectly elastic properties, and it is only for that range of stress that you can count on its standing an indefinitely large repetition of working stress. Now it is upon the range between which the elastic limits lie that the structural value depends in cases—and they are the commonest cases—where the structure is subjected to alternations of loading; and I call special attention to that now, because we have come to be perhaps too much in the habit of assuming—no doubt in a particular sense rightly enough, but still without sufficient foundation, and in a way which is sometimes erroneous—that the structural value of a material is determined almost entirely by its breaking stress. All commercial testing proceeds mainly in determining the breaking

stress of a material, and by the breaking stress under a load applied in the course of perhaps five or ten minutes. I want just at this point to call your attention to the fact that it is not necessarily true that two materials with the same breaking stress have the same range of elasticity, or that of two materials one say has a higher breaking stress than the other it will also have a greater range of elasticity, or be suitable for a greater range of working stress. For the present, we are obliged to judge materials very much by their breaking stress, and no doubt, generally speaking, the material of higher breaking stress is the better material for construction, but we must not rely on that as anything like an absolute truth.

Now an idea of the action which goes on in testing can best be indicated by making use of a stress-strain diagram. Suppose we subject a bar of any ordinary ductile material like wrought iron or steel to a tensional test, and exhibit the result graphically. If we take the extensions of the bar under the load as abscissæ, and the loads as ordinates, we shall for a certain range of stress get the relation of the stress and strains shown by a straight line, O A, Fig. 1.

Fig. 1.



So long as the stresses are proportioned to the strains, the curve which exhibits the proportion between the stress and strain will be a straight line. At some load—for wrought iron about 13 or 14 tons to the square inch—the straight line will pass a little into a curve, the strain will begin to increase more rapidly than the increase of the load, and then we reach—in materials like rolled iron or steel—a rather remarkable point, B, where the bar suddenly elongates through a distance which is very considerable compared with its previous elongation. That point, so far as I know, was first noticed very distinctly by the committee of Civil Engineers who investigated steel in the year 1868, and they called it the yielding point, that is, the point where the material yields. After the material has yielded through a distance something like 100 times its whole previous elongation, it acquires again somewhat more rigidity; the loads begin to increase again, and we get for the relation of stress and strain a curve passing off as shown by B C. The load increases up to a certain maximum at C, and the maximum load which we get upon the bar, although it is not the breaking load, we conventionally call the breaking load. After reaching the maximum load, we shall find the bar is not generally then broken, but by diminishing the load it can be extended farther, and so we get the falling part of the curve, corresponding to a period during which the load is diminishing, and the bar rapidly elongating, and at some point it suddenly breaks.

I have no doubt that kind of diagram is now familiar to many of you, and I want to point out two respects in which it conveys a false impression. The diagram does no doubt represent exactly the loads applied and the actual corresponding extensions of some portion of the bar, originally, say, 8 or 10 inches long. But what is most wanted, and what the diagram is sometimes erroneously taken to represent, is the relation between the stresses in the bar, and the extensions per unit of length corresponding to those stresses. It must be pointed out that the loads are acting on a constantly diminishing section, so that the stresses are increasing faster than the loads, and further that, beyond a certain stage, only a portion of the bar continues to elongate so that the extensions are really extensions of a very short portion of the bar only. During the very early part of the extension, O A, which is very much exaggerated in the diagram, the section of the bar does not sensibly change, but during the very large deformation which goes on afterwards, the section of the bar not inconsiderably diminishes. If we can measure or calculate the reduced section during the test, and from that re-calculate the stress per square inch of the bar, we shall get a curve, O A E, which, agreeing with the straight elastic line at first, will afterwards be considerably above the curve we previously plotted. The stress per square inch of the actual section

of the bar is larger than the stress calculated on the original section of the bar. We can proceed in that way up to the point at which the maximum load is reached. Beyond that point the process fails, and this latter part of the diagram especially makes a wrong impression. At some point (which must lie very near the point at which the maximum load is reached, if it is not that point), the bar, instead of elongating all over, elongates locally. The elongations become elongations not of the whole measured length of the bar between the gauge points, but elongations of a comparatively short length of the bar. Hence in the diagram as ordinarily drawn, the extensions up to C are extensions of, say, an 8in. or 10in. length, and the extensions from C to D, extensions of only a very short length of perhaps $\frac{1}{4}$ in. or $\frac{1}{2}$ in. If from the reduced section of the bar at the local contraction, which can, if necessary, be measured during the test, we calculate what would be the extension of the whole bar if it extended at the same rate, the diagram can be corrected. We get then the diagram O A E F, which gives the relation of the real stress and real strains at the part of the bar which is really tested.

The discussion of the stress strain diagrams is important, in order to get clear ideas of exactly what the results of ordinary testing mean, and to avoid some common misconceptions. What is commonly called the breaking stress of a bar is not the real breaking stress, and is calculated on area which has been considerably altered before the breaking occurs. The so-called breaking stress is, to a great extent, a fictitious quantity, and that ought to be borne in mind in determining its value as a criterion of quality.

So again, the so-called ultimate elongation per cent. is merely an average of the elongations of a length of bar, the parts of which have elongated very differently, and that percentage will vary for every different length of the bar for which it is calculated. It is very difficult to alter practical habits, or it might be argued with considerable force that the elongation at the point of maximum loading is a much better criterion of the quality of a material than the ultimate elongation ordinarily taken.

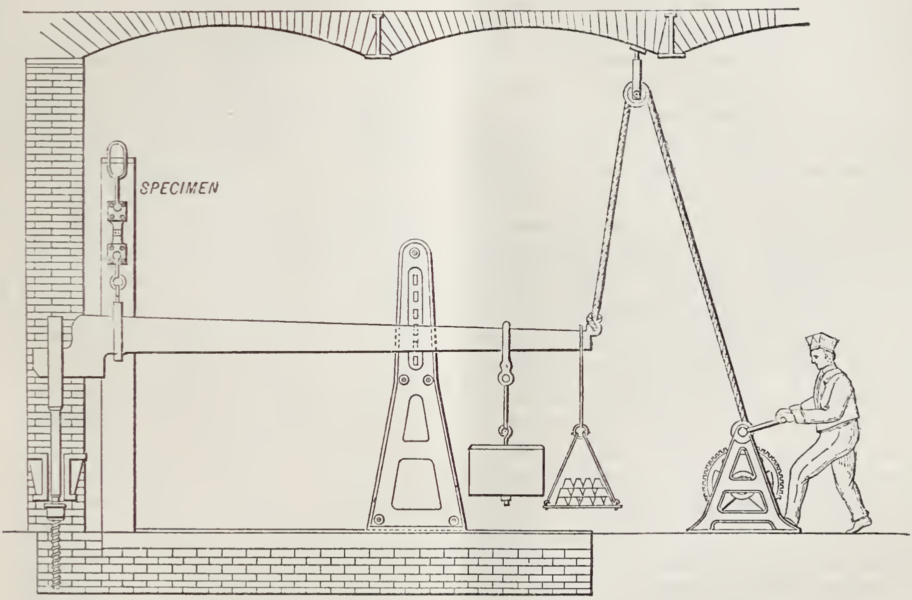
Testing Machines.

The variety of purposes to which a testing machine is to be applied determines very much whether it can be a comparatively simple, or must be a complicated machine. If the machine is to be used merely for determining the quality of one kind of material, it will be desirable to test pieces of the same size, and of some simple form, and then a very simple kind of machine can be adopted. If, however, the experimental investigation is of various materials, and intended for various kinds of straining action, especially if the experiments have to be carried out on complete portions of structures, then the testing machine must be complicated, and must have a variety of accessory appliances. Hence one may say at once there is no absolutely best testing machine; there is no one testing machine preferable to all others; almost every testing machine has some special merit for some particular kind of work. There are testing machines applicable to varied purposes, and testing machines which are like special tools in a workshop, only adapted for doing rapidly some particular kind of work. The simplest mode of testing is by applying directly a testing weight or dead load. Very many of the earlier experiments, for instance, of Hodgkinson, were made in this way. Cast iron, which is not a very strong material, is often tested by imposing a dead load on the bar. Now, except for materials of very small section, it is inconvenient to have to deal with such very large test weights as would be required if we used a dead load, and thus it is more common to use a lever, because then we have only to handle a load which is less than the stress of the bar in the ratio of the lever arms. Many of the earlier testing machines consisted simply of a large lever. The machine shown here (Fig. 2, p. 795) is an old machine constructed by Sir William Fairbairn, used for many years by Hodgkinson, and which I also used very often. It was simply a very large wrought iron lever having a scale platform at one end, in which weights could be placed, and attached by a shackle to a strong foundation at the other end. The specimen was placed between the fixed abutment and a knife edge on the lever. A machine of that type has this one great inconvenience: as you increase the load in the scale the specimen stretches, and the lever becomes greatly inclined, so that it is necessary to lift the lever by a crab, and to tighten up the abutment which holds the fulcrum under the lever, and then to proceed to add more weight. When the lever again becomes inclined you have again to lift the lever, and again tighten the nut. That involved so much delay, that the next step in

testing machines was to do away with the lever, and to pull the test specimens directly by means of a hydraulic press. The test specimen was held at one end to a fixed abutment, and pulled the other end by a hydraulic press, and as the ram of the press can move through a long distance, the strain of the specimen can be taken up without any delay for adjustment. But then it became necessary to ascertain the load on the specimen from the pressure in the hydraulic press cylinder, and that involves many difficulties, of which I shall speak in my next lecture. I may say, however, that there are certain purposes which testing machines constructed in that simple way may usefully subserve.

Then the third step taken in testing machines was to combine those two methods. In almost all modern testing machines the specimen is held between a lever-weighing apparatus, and a hydraulic press which takes up the elongation of the bar. We may put it roughly by saying that in modern testing machines the load is applied by the hydraulic press, and weighed by a lever-weighing apparatus, so that a modern testing machine consists essentially of a weighing apparatus, and a pulling apparatus, and of certain accessory apparatus between, intended to hold the specimen. The varieties of testing machines may be classified primarily by variations in the mode in which the weighing of the stress is

FIG. 2.



conducted. Let us consider first of all an ordinary lever-weighing apparatus. The pull of the specimen, supposing we were weighing it, as if by a platform weighing machine, would pull the lever up against a stop on its upper side. We place weights in the scale until the lever comes to a balance between the upper and lower stops. Then the moment of weight about the fulcrum is equal to the moment of tension of the specimen under pull, and from knowing the ratio of the lever arms, you can get the load on the specimen. The simplest mode of applying the weight is of course to use a scale pan or platform, in which the separate weights are placed. That method is adopted even in one of the most modern machines, the Werder machine, which is largely used in Germany. You have a scale pan, in which several weights are placed until the lever is in balance, and that gives you the tension of the specimen; but placing separate weights in the scale platform is a somewhat laborious operation, and there are methods of diminishing the labour.

One ingenious method is used in many chain cable testing machines, in the great testing machine at Watertown, U.S., and in the new machine constructed at Berlin by Herr Martens. A series of weights are carried by a frame in

such a way that, by lowering the frame, they are one by one quietly placed on stops on a bar suspended from the lever. The frame has an arrangement of gearing by which it can be raised or lowered, and by raising or lowering it the weights are either taken by the frame or placed on the lever.

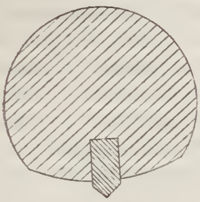
There is another way out of the difficulty of using separate weights, and that is to use what we may called a jockey weight, or travelling weight, which moves along the lever. Having a constant weight and altering the leverage comes to the same thing as varying the weight with a constant leverage. This weight rolls out along the lever arm, and enables you to increase the tension on the specimen in the easiest way possible. In most cases the jockey weight is suspended by a roller from the lever arm, but in some machines the weight takes the form of a large weight on the lever arm itself. The use of a single weight is shown in Wicksteed's machine, and so far as I know, he was the first to recognise that it would be an advantage in using a jockey weight of this kind, to have the centre of gravity of the weight and of the lever as nearly as possible in a line passing through the knife edges of the lever. Then variation of inclination of the lever would very slightly affect the ratio of the tension on the specimen, and the weight on the lever. There is yet one other way in which the load on the specimen may be extremely simply varied. In a very interesting machine constructed in Germany by Polmeyer, the weight is applied by means of a hanging pendulum; there is a long pendulum carrying at the foot a weight of about one ton. The pull of the specimen is transmitted to the short arm of a bent lever, and as this is pulled, the long arm which holds the weight moves outwards in the arc of a circle, and the moment of the weight about the fulcrum increases. Apart from certain difficulties connected with the inertia of such a moving weight, that is an extremely convenient and simple way of applying the load.

In a few machines, the description of which will properly belong to the next lecture, the weight has been got rid of entirely by using a kind of frictionless piston supported by fluid, by which the pull of the specimen is taken, and by a pressure gauge giving the pressure on the piston, we may get the load at the end of the specimen as accurately as if we weighed it by actual weights. The exact mode of forming this frictionless piston I must describe next time; but I think I have now covered all the methods by which the weighing of the stress on the specimen is accomplished.

In the construction of the weighing apparatus, there is no detail of any special interest or importance, except the construction of the knife edges on which the lever rests. It is absolutely essential in the weighing apparatus of a testing machine to achieve the greatest possible sensitiveness. A good testing machine carrying 100 tons will show distinctly and decisively a difference of stress in the specimen of $\frac{1}{100}$th of a ton, that is, it will show a variation of $\frac{1}{10000}$th of the load. I believe that is a sensitiveness as great as the sensitiveness of a good chemist's balance. To achieve a sensitiveness of that kind, we must have the lever resting, not in journals, the friction of which resists motion, but on exceedingly accurately formed knife edges. In originally selecting a testing machine, the consideration of the knife edges troubled me a great deal. You are in this difficulty. In the first place you must have a very fine edge—it is perhaps something of an exaggeration to call it a knife edge, but it is an exceedingly fine edge even in a 100-ton testing machine, and in order that that edge may stand the load of 100 tons, it has to be made as hard as you can possibly make it. Now in hardening a knife edge it is very apt to become twisted, and if it becomes twisted you have virtually a broadening of the edge. A very small amount of twist in the knife edge will make a virtually broad edge, far too unsensitive for a good testing machine. The knife edges I first saw were formed out of a solid bar, with the edge formed on one side. The whole bar was got up as true as possible, and the knife edge as true as possible, and then the whole bar was hardened, but I came to the conclusion that by that mode of construction it would be impossible to avoid some kind of twisting in hardening a long knife edge, and it occurred to me it would be better to make the hard part of the knife edge a very small portion of the bar, and leave the rest unhardened. Mr. Wicksteed, having given a good deal of thought to the matter, adopted that suggestion, and improved upon it, and as the mode of making knife edges is rather interesting, I will describe it. The small portion of the bar which forms the real knife edge is made of the very best steel, got up as true as possible in the soft state. Then a slot in the bar into which it is to fit is also made, and the small knife edge, which has to be

hardened, is fitted accurately into the slot in the large bar. It is fitted by scraping and grinding in, so that it is as close a fit as possible. Then this small portion which has to be hardened is taken out and hardened, and if in hardening it twists, it all comes back very nearly to straightness by being forced into the grove in which it was previously ground (Fig. 3). Having been forced back

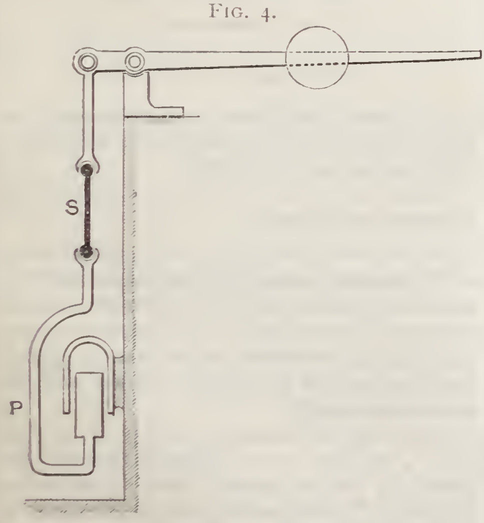
Fig. 3.



into its place, it gets a final touch by grinding with an emery wheel. After it has been hardened, you cannot do very much with it, but you can do a little to improve the straightness of the edge, and it gets a final grinding after it is refitted into the bar.

Now I will describe briefly two machines which show the general arrangement of a testing machine in its simplest form, a form which has been used in various ways for some time, and which has been very greatly per-

Fig. 4.



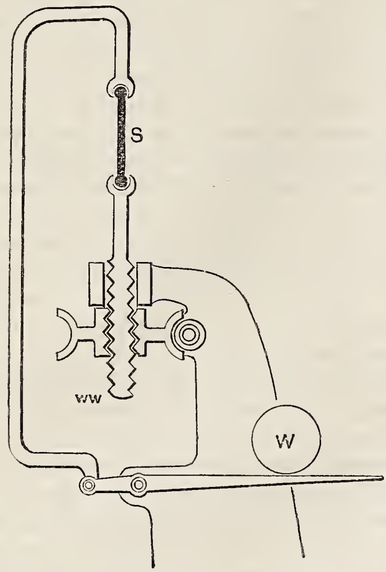
fectly by Mr. Wicksteed. It is the form of testing machine which I use myself, two 100-ton machines having been made under my direction, one for Cooper's-hill College and one for the Central Institution of the Guilds of London (Fig. 4).

S is a diagramatic representation of a test bar held between two shackles; the shackle at one end is attached to the short arm of a single lever, and the shackle at the other end to the ram of a hydraulic press. The lever machine shown here has a single jockey weight which is rolled out along the lever. As it rolls out, and the bar stretches, water is pumped into the hydraulic press so as to take up the elongation, and keep the lever floating. The general scheme of the machine is about as simple as possible. One peculiarity of the Wicksteed machine which attracted my attention when deciding on the selection of a form of machine was the exceedingly good way in which the hydraulic press pulling the specimen was worked. In most testing machines the hydraulic press is worked, as such presses are ordinarily worked, by pumps, but in working a press by pumps, as they act stroke by stroke, a certain volume of water is forced into the press, and the water being extremely incompressible, every stroke of the pump produces a shock on the machine. In any kind of testing it is not desirable to have the specimen bar subjected to a series of shocks, especially when the bar is in the semi-plastic condition in which it is towards the end of the test. In place of the pumps, there have been used in one or two machines what is very much better, but more expensive—an accumulator. But an accumulator is not always at hand to work a testing machine; it is rather an expensive construction. Mr. Wicksteed adopted a plan previously used in the Thomasset testing machine. To force the water into the hydraulic press there is a second hydraulic press, having a ram of smaller diameter, and very much longer. That second press is worked by screws driven by a belt from an engine. The ram of the second press is slowly screwed in at a perfectly regular rate by the screws, and throws the water over into the press at a faster or slower rate according to the elongation of the test bar, or according to the direction given to the action of the machine. In that way water is forced into the press without producing any vibration or shock.

Fig. 5 (p. 798) is a diagram of a Fairbanks machine, which is a machine of the same type, with the single exception that worm-gearing is substituted for a hydraulic press to take up the elongation. Worm-gearing is an exceedingly nice steady mechanism for producing power of this kind on a specimen, but it involves very large waste of work. The friction of

worm-gearing is very large indeed, and although in America they do seem able to to make this worm-gearing sufficiently free acting to be used on even rather large

FIG. 5.



machines, the waste of work must be considerable; indeed, probably the efficiency of the worm-gearing is not over about 30 per cent.

FIG. 6.

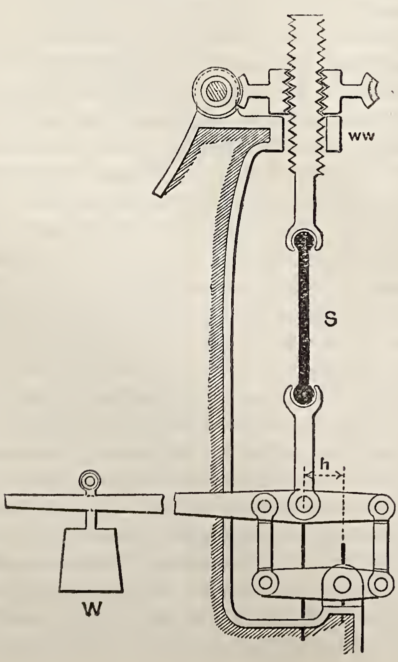


Fig. 6 shows the machine of Grafenstaden. In this there is the same kind of worm gearing to produce the pull at one end, and a single lever corresponding to the single lever of the Wicksteed machine, but in this machine it has been the object to get a very much shorter fulcrum distance than in the Wicksteed, in order to have smaller weights to handle, and a shorter lever. In the Wicksteed machine the distance between the principal knife edges is three or four inches. In this machine the distance is only the fraction of an inch. To get that very short fulcrum distance some device must be adopted, because there is no room with a single lever to get the knife edges so close together. In this machine there is a very pretty link-work, by means of which the fulcrum distance can be made as short as you please, and you are not tied to get the knife edges close together. In this case the leverage is 100 to 1, so that the weights to be handled are moderate, and the fulcrum distance is so small that the lever is not of any great length. The same arrangement is used in the testing machines of Riehle Brothers in the United States.

Miscellaneous.

IMPERIAL INSTITUTE.

On Monday, the 4th inst., the foundation-stone of the building at South Kensington, for the Imperial Institute, was laid by the Queen.

H.R.H. The Prince of Wales read the following address to her Majesty:—

May it please your Majesty,—We, the President of the Imperial Institute and the Organising Committee appointed to advise upon the form and constitution of that memorial of the 50th anniversary of your Majesty's accession to the Throne, approach your Majesty with the expression of our heart-felt affection and loyalty.

It has been our desire, in pursuance of the ideas which gave birth to the Colonial and Indian Exhibition of 1886, to combine in some harmonious form a broader and more enduring representation of your Majesty's Colonies and India, as well as of the United Kingdom; and our confident hope is that this Institute may hereafter not only exhibit the material resources of the Empire, but may be an emblem of that Imperial unity of purpose and action which we believe has gathered strength and reality with every year of your Majesty's reign.

We would also express our hope that this institution may promote the commercial and industrial prosperity of all parts of your Majesty's dominions, and that the scientific and technical education which the requirements of modern industry render necessary may through its means receive fresh development.

In praying your Majesty to associate yourself with this work, we trust that we shall not err if we venture to remind your Majesty of yet one more consideration which may enhance your Majesty's personal interest in this undertaking, even if we refer to a never-forgotten sorrow.

More than thirty-six years ago, under the counsel and wise guidance of your Majesty's illustrious and lamented Consort, my beloved father, the Exhibition of 1851 gave a vast impulse to commercial activity and set an example which has been often followed in the countries both of the old and of the new worlds. The creation of an Imperial Institute would seem to be a fitting development and completion of the work thus wisely and usefully initiated.

The financial success of that great and bold enterprise has enabled your Majesty's Commissioners to grant this site for the purpose of the Institute, and thus to render the entire fund contributed by your Majesty's subjects directly available for its erection and maintenance.

In this tribute of love and loyalty every class and race, every colony and country that owns your Majesty's beneficent sway will take part, and in it they will see a record of those fifty years of public progress and prosperity which will make your Majesty's reign famous in English history.

It is our earnest hope that the building, of which your Majesty to-day lays the foundation-stone, will tell to many generations yet to come the story of the long and happy reign of our gracious Sovereign.

Her Majesty then read the following reply, which was handed to her by the Secretary of State for the Home Department :—

It is with infinite satisfaction that I receive the address in which you give expression to your loyal attachment to my Throne and person, and develop the views that have led to the creation of the Imperial Institute.

I concur with you in thinking that the counsels and exertions of my beloved husband initiated a movement which gave increased vigour to commercial activity, and produce marked and lasting improvements in industrial efforts.

One indirect result of that movement has been to bring more before the minds of men the vast and varied resources of the Empire over which Providence has willed that I should reign during fifty prosperous years.

I believe and hope that the Imperial Institute will play a useful part in combining those resources for the common advantage of all my subjects and in conducing towards the welding of the Colonies, India, and the Mother Country into one harmonious and united community.

In laying the foundation-stone of the building devoted to your labours, I heartily wish you God speed in your undertaking.

NATIONAL ASSOCIATION FOR THE PROMOTION OF TECHNICAL EDUCATION.

The inaugural meeting was held on Friday last, 1st inst., at the rooms of the Society of Arts, for the purpose of appointing an executive and forming a programme for the Association. The Marquis of HARTINGTON presided.

Lord HARTINGTON, in opening the proceedings, said their object was not so much to stimulate public attention in this great question as to consider from a practical point of view the channels into which such interest ought to be directed. He had been struck by the facts relating to technical education at home and abroad which had been presented in very voluminous form to the public in the reports of our Consuls. We had in this country attained to a great industrial and technical supremacy in the world. We had attained this position partly by the possession of great resources in coal and iron and other industrial materials, partly from the character, energy, and industry of our people, and partly—and here he might be trenching upon controversial grounds — from the fact of our having adopted a sound commercial policy. At the same time, concurrently with our attainment of this supremacy, wonderful scientific discoveries had been made, and more and more science was being applied to the industrial occupations of the world. Other nations had been quick to perceive this, and were striving to make their position equal to ours by developing, at immense cost to the State and public funds, that scientific instruction which would enable their manufactories and workmen to compete successfully with ours. If we were passive in the matter—if we were indolent—it was conceivable not only that foreign nations would rival us, but they might also succeed in passing us, with consequences which it would be difficult to contemplate. If we were satisfied to go on as we were, if we were content to rely in the future as we had done in the past on those advantages which had given us our present position, and if we did not think it necessary to organise more completely our system of technical instruction than at present, that decision should be the result of deliberate and well-formed consideration, and not the result of apathy or indolence.

Sir LYON PLAYFAIR, M.P., moved that the Association be formed, that Lord Hartington be invited to become president, and the following gentlemen vice-presidents :—Lord Granville, Lord Ripon, Lord Rosebery, Lord Spencer, the Bishop

of London, Mr. Broadhurst, M.P., Professor Huxley, Sir John Lubbock, M.P., Mr. Mundella, M.P., Sir Lyon Playfair, M.P., Sir B. Samuelson, M.P., Professor Stuart, M.P., Dr. Sullivan, Sir R. Temple, M.P., and Professor Tyndall.

Mr. John Morley, M.P., in seconding the motion, said the time for further inquiry had gone past, and the time had arrived when they could no longer with wisdom, or even with safety, delay the movement they that day commenced. The resolution was carried unanimously.

Sir J. Lubbock, M.P., moved the appointment of an executive committee, which was carried; as was a motion, made by Mr. Mundella and seconded by Lord Rosebery, that those present be invited to join the council.

A discussion ensued on the proposed objects of the Association, after which Sir B. Samuelson, M.P., moved, and Mr. Howell, M.P., seconded, a resolution inviting the assistance of large towns and chief industrial centres. The motion was duly carried, and votes of thanks closed the proceedings.

COINAGE OF 1886-87.

The following particulars respecting the coinage of 1886, and the new coins and Jubilee medals of 1887, are taken from the Seventeenth Annual Report of the Deputy Master of the Mint (the Hon. C. W. Fremantle, C.B.).

During the year 1886 the Australian gold coin received by the Bank of England amounted to £2,187,000, entirely in sovereigns, which was less by £825,000 than the importations of the previous year. The total amount of these coins received by the Bank during the ten years from 1877 to 1886 has been £23,025,000, giving an average of £2,302,500 a year.

The silver coinage of the year presents no special feature, except that the demand for coin has been considerably under that of the three preceding years. The amount struck was £420,415, and the amount issued £430,798, which is less by nearly £200,000 than the issue of 1885. Of this sum £254,000 was delivered to the Bank of England, £40,000 to the Bank of Ireland, £108,025 was sent to Colonies, £10,475 was shipped for the use of Treasury chests abroad, and £18,100 was supplied in threepences direct to banks and private applicants. The balance consisted of Royal "Maundy" moneys.

The amount of threepences issued in the year was £49,230, or less by £11,500 than the issues of this coin in 1885. The Colonies again were large applicants for threepences, no less than £23,500, or nearly half the total amount issued, having been sent abroad during the year. Indeed the Colonial demand increases yearly. In 1884 it amounted to £6,075 only, while in 1885 it rose to £21,500, and last year, as already stated, the total reached was £23,500. Of this amount £20,000 was transmitted to the Australian Colonies, and £2,000 to New Zealand. Fourpences of the nominal value of £1,200 were withdrawn from circulation during the year in the United Kingdom.

The half-crowns issued in 1886 were of the nominal value of £130,695, as against £164,700 in 1885, and the total amount of these coins added to the circulation since 1874, when their coinage was resumed, has been £2,243,485. Half-crowns as yet do not appear to have found special favour in the Colonies, as, since the resumption of their coinage, the shipments abroad have only amounted to £422,000, as against £636,000 of florins. On the other hand, judging from the amounts of half-crowns and florins, respectively, issued during the last few years, there would seem to be a growing preference at home for the former coin.

The bronze coinage of the year 1886 amounted to £51,344, and the issues to £42,610, as against £53,361 and £56,840, respectively, in 1885.

The Colonial coinages executed by the Mint in 1886 were more numerous and of greater nominal value than in any previous year. The number of silver coins struck in connection with these coinages was 9,850,000, and that of the bronze pieces 1,849,200. The coinages were sixteen in number, as against twelve in 1885, and consisted of four silver coinages and one bronze coinage for Canada, in twenty-five, ten, and five-cent pieces, and cents; three silver coinages for Hong Kong, in twenty, ten, and five-cent pieces; four bronze coinages for Cyprus, in piastres and half-piastres; three silver coinages for the Straits Settlements, in fifty, twenty, ten, and five-cent pieces; and one silver coinage for Mauritius, in pieces of twenty and ten cents.

The effigy of the Queen which was adopted for the coinage at her Majesty's accession in 1837, and was modelled by the late Mr. William Wyon, R.A., modeller and engraver of the Mint, still remains in use. During the past year her Majesty was pleased to signify her pleasure that a portrait medallion, by Mr. J. E. Boehm, R.A., modelled from life, should be substituted for the effigy which the coins have hitherto borne, and steps have been taken for the preparation of dies for the coins of the different denominations. In the new effigy her Majesty appears crowned and veiled, with the Riband and Star of the Garter, and the Victoria and Albert Order. The legend, "Victoria Dei Gratiâ Britanniarum Regina, Fidei Defensor," is variously arranged on the different coins, according to the exigencies of the design on each.

The opportunity has at the same time been taken, with her Majesty's approval, for making certain alterations in the designs for the reverses of some of the coins, by abandoning those which do not appear to possess sufficient artistic merit to warrant their retention. In some cases no change has been made. The reverse of the sovereign will still bear

the design of St. George and the Dragon, by Pistrucci, first adopted for the sovereigns of George IV., and the reverses of the half-sovereign and threepence remain unchanged, except that the crown has been assimilated to that used for the new effigy. The St. George and Dragon design will be resumed for the five-pound piece, the double sovereign, and the crown, this design having been adopted for these pieces when originally struck. The half-crown will bear the same reverse as that coin bore when first issued, a design of considerable merit by Merlin. During the last half-century public taste appears to have been satisfied, both in this country and abroad, with some such insignificant design as a wreath surrounding words or figures indicating the value of the coin, and the shilling and sixpence have during the present reign been examples of this treatment. They will in future, like the half-crown, bear the Royal arms, crowned, and surrounded by the Garter.

One addition will be made to the coins now in circulation by the issue of a double florin. The reverse is composed of crowned shields, bearing the arms of the United Kingdom arranged in the form of a cross between sceptres, a device which was first adopted for coins of Charles II., and the pedigree of which from early Saxon times was traced in a former report. It was designed by Thomas Simon, the greatest of all English engravers, and it remains to be seen whether this handsome coin will be generally popular. The reverse of the florin will for the future bear the same design.

The Queen was further pleased to command that the fiftieth anniversary of her Majesty's accession should be commemorated by the issue of a medal. The effigy for this medal, which is also from a medallion by Mr. Boehm, has a somewhat more ornate veil than that on the coin, and on the bust, in addition to the Victoria and Albert order, is shown the badge of the Imperial order of the Crown of India. The reverse is a beautiful work by Sir Frederick Leighton, President of the Royal Academy, of which the following is a description:—"In the centre a figure representing the British Empire sits enthroned, resting one hand on the sword of Justice, and holding in the other the symbol of victorious rule. A lion is seen on each side of the throne. At the feet of the seated figure lies Mercury, the God of Commerce, the mainstay of our imperial strength, holding up in one hand a cup heaped with gold. Opposite to him sits the Genius of Electricity and Steam. Below, again five shields banded together bear the names of the five parts of the globe, Europe, Asia, Africa, America, and Australasia, over which the Empire extends. On each side of the figure of Empire stand the personified elements of its greatness—on the right (of the spectator) Industry and Agriculture, on the left, Science, Letters, and Art. Above, the occasion of the celebration commemorated is expressed by two winged figures representing the year 1887 (the advancing figure) and the year 1837 (with averted head), holding each a wreath. Where these wreaths interlock the letters V.R.I. appear, and over all the words 'In Commemoration.'"

THE PREPARATION OF ARROWROOT IN BERMUDA.

According to the last report of the United States Commissioner of Agriculture, it appears that of late years a considerable impetus has been given to the cultivation and preparation of arrowroot in Bermuda, and large quantities are annually exported from the island. In cultivation, the method adopted is very similar to that practised in the culture of the common potato. The ground is first well manured and ploughed deep; it is then harrowed and laid out in drills about six inches in depth and three feet apart. In these drills the roots are set about eight inches apart, covered with the plough, and the surface smoothed by harrowing. The plants require at least a year to mature, and economical planters set the drills somewhat wider apart, and introduce an intermediate row of the potato, the crop of which is ready for removal before it can injure the arrowroot crop. Indian corn is occasionally planted in these rows, which is cut for forage when green, as, if it is allowed to mature, the main crop would be impaired by it. The mode of preparing the fecula from the roots greatly influences its value, and the superiority of the Bermuda arrowroot is attributed to the extreme care and cleanliness exercised in the different processes of manufacture. The roots, after being collected, are washed, and their outer skin completely removed; this operation has to be performed with great nicety, as the cuticle contains a resinous matter which imparts colour and a disagreeable flavour to the starch which no subsequent treatment can remove. After this process, the roots are again carefully washed, and then crushed between powerful rollers, which reduce the whole mass to a pulp; this is thrown into large perforated cylinders, where it is beaten by revolving wooden paddles, while a stream of pure water carries off the fecula from the fibres and parenchyma of the pulp, and discharges it, in the form of milk, through the perforated bottom of the cylinder, from whence it is conveyed in pipes and passed through fine muslin strainers into large reservoirs, where it is allowed to settle, and the water is drawn off. After being repeatedly washed, it is allowed to settle for some time, when the surface is skimmed with palette knives of German silver, in order to remove any slightly discoloured particles which may appear on the top, and retaining only the lower, purer, and denser portion for drying for market. The rollers and cylinders are made of brass and copper, in order to preserve the purity of the material. The drying process is conducted also with great care and cleanliness. The substance is spread

in flat copper pans, and immediately covered with white gauze to exclude dust and insects. These pans are placed on rollers, and run under glass covered sheds when there is any danger from rain or dews. When thoroughly dry, it is packed with German silver shovels into new barrels, these being first lined with paper, which is gummed with arrow-root paste.

Notes on Books.

Technical School and College Building. Being a Treatise on the Design and Construction of Applied Science and Art Buildings, and their suitable Fittings and Sanitation, with a chapter on Technical Education. By Edward Cookworthy Robins, F.S.A. London: Whitaker and Co. 1887.

Mr. Robins has brought together in this quarto volume a large amount of information on the subject of Technical Education as taught both in England and abroad, and on the adaptation of architecture to the requirements of this teaching. In dealing with this new branch of architecture, Mr. Robins has brought to bear upon the subject the results of his inquiries, and his experience in planning not only the buildings themselves but the appliances contained in those buildings. The second chapter contains an analysis of the Second Report of the Royal Commissioners on Technical Education; the third, a description of foreign buildings for applied science and art instruction; and the fourth, a description of English laboratories. The fifth chapter contains an analysis of the general principles and practice in regard to the fittings necessary for applied science instruction buildings, and the sixth, British and foreign examples of such fittings. Subsequent chapters are devoted to the subjects of heating and ventilation, to the planning of buildings for middle-class education, and to sanitation in its relation to civil architecture. The volume is fully illustrated, and is dedicated to Professor Huxley.

Jamaica at the Royal Jubilee Exhibition, Liverpool, 1887. By G. Washington Eves. London: Spottiswoode and Co. 1887.

This volume contains a general account of the island and of its administration, of the public gardens and plantations, of the natural history, and of the means of communication. Chapters on the climate and on Jamaica as a health resort are added. Mr. Eves, in his introduction, argues strongly for the maintenance of the sugar industry, which he considers of exceptional importance to a West Indian colony.

A Pocket Dictionary of Technical Terms, English-French and French-English, with Tables, suitable for the Architectural, Engineering, Manufacturing, and Nautical Professions. By John James Fletcher. London: Crosby Lockwood and Co., 1887.

This little glossary is made of a suitable form for the waistcoat pocket, and contains, besides the most used technical terms, a series of tables of weights and measures and money, with constants for calculation.

A Treatise upon Cable or Rope Traction, as applied to the working of Street and other Railways. By J. Bucknall Smith. London: Office of *Engineering*. 1887.

This account of a special form of tramway work is a revised and enlarged edition of articles which appeared in *Engineering*. The main object of the work is to describe the application and development of the "Endless Cable Haulage System," which was introduced in 1873 for working street railways in San Francisco, and was adopted on Highgate-hill in 1883. A chapter is devoted to an account of the manufacture of wire and wire ropes, and of their applications. A large number of figures illustrate the descriptions in this volume.

General Notes.

Wiesbaden Scientific Exhibition.—On the occasion of the 60th Congress of German Naturalists and Physicians, to be held in Wiesbaden, from the 15th to the 24th September, 1887, a Scientific Exhibition will be arranged in connection with the Congress. The purpose of the exhibition is to show at a glance the latest and most perfected instruments and apparatus, and the arrangements adopted will be as follows:—1. Surgery, physical diagnosis, and therapeutics. 2. Ophthalmology. 3. Gynaecology. 4. Laryngology, rhinology, and otiatry. 5. Orthopaedia. 6. Dentistry. 7. Chemistry. 8. Instruments of precision, with subdivision for microscopy. 9. Instruments and apparatus aiding instruction in natural history. 10. Geography. 11. Equipment for scientific travel. 12. Photography. 13. Anthropology. 14. Biology and physiology. 15. Hygiene. 16. Electro-therapeutics and neurology. 17. Pharmacology. No charge whatever will be made for space, insertion in catalogue, or anything else in the exhibition, and the instruments, while there, are covered against risk by fire at the expense of the committee. Applications are to be addressed to the Ausstellungs - Committee der 60 Versammlung Deutscher Naturforscher und Aerzte, 44, Frankfurterstrasse, Wiesbaden.

Journal of the Society of Arts.

No. 1,808. Vol. XXXV.

FRIDAY, JULY 15, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

MACHINES FOR TESTING MATERIALS, ESPECIALLY IRON AND STEEL.

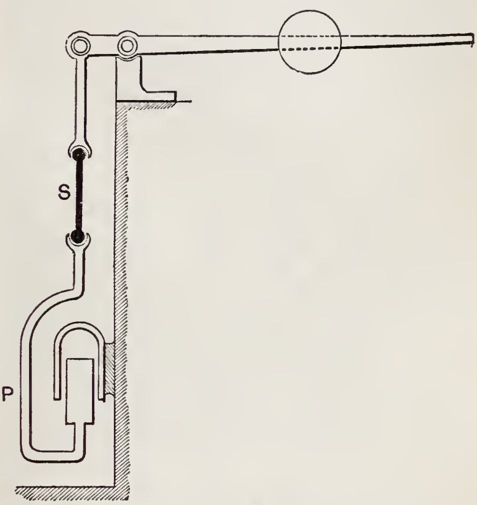
By Prof. W. C. Unwin, F.R.S., M.I.C.E.

Lecture II.—Delivered March 28th, 1887.

All the testing machines which I described in my first lecture had one feature in common, they were all what we call vertical machines, that is, the pull of the specimen was exerted vertically. A vertical machine has one distinct defect—it is not suitable for very long specimens. On the other hand, for the kind of testing that has most commonly to be done, when specimens are not more than a few feet in length, the vertical machine has two distinct advantages. The first advantage is, that in tensional testing—and nearly nine-tenths of ordinary testing is tensional testing—you do not need the interposition of anything in the form of a guide between the knife edge of the machine and the specimen, that is, between the weighing apparatus of the machine and the specimen. A guide may be made so as to introduce very little frictional resistance, if it is in good adjustment, but it is better, if possible, to be without a guide, and the error that a guide may by chance introduce. That is one advantage of the vertical machine. But another advantage, which I think of more importance, is that no machine lends itself so conveniently to calibration as the vertical testing machine; and as I hold that no testing machine is to be trusted until it has been calibrated, I think I may, perhaps with advantage, devote a little time to explaining calibration, because that is a point which I think has been too much neglected, and which I have not anywhere seen described.

The two machines with which I have lately had much to do are two machines of the type (Fig. 7) constructed for me by Messrs. Buckton, and the process of calibration to which I have had those subjected I will very briefly describe. In this machine you have a single horizontal lever resting on a knife edge. The loading is effected by a single one-ton weight, which travels horizontally along the arm of the lever. The first adjustment to be made is to bring this lever into absolute balance when there is no

Fig. 7.



specimen in the machine. Travel the weight back to a point a little behind the fixed knife edge, and you find the lever comes into a position of absolute balance. Having got the lever in that position of balance, you adjust a vernier which is attached to the jockey weight, so as to read zero on a long uniform scale which extends along the arm of the lever. In the machine I am speaking of, the fulcrum distance—the short arm length of the lever—is four inches, and every four inches the jockey weight moves from the zero of the scale, when it has been properly adjusted, puts one ton on the specimen. Now the first piece of calibration to be done is to test whether this jockey weight really weighs a ton, because if it does not, the whole of the indications of the machine are wrong. The test I found for that is a very simple one. The long scale on which the movement of the jockey weight is read off extends along the lever, and one division of the

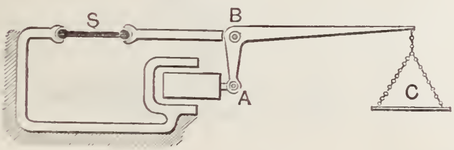
scale can be seen to coincide precisely with the principal knife edge. If the jockey weight is run back past this principal knife edge to the position of -1 on the scale, it ought to balance a weight of 56 lbs. hung at a leverage of 40 on the other side of the principal fulcrum. That is a test very easily applied. The jockey weight is run back to the position of -1, is balanced by 56 lbs., at a leverage of 40, 40 times 4 inches from the principal knife edge. Of course the jockey weight is a weight that is standardised before it is put on the machine, and it ought as little as anything to require calibration. But that even that test is not unimportant, was very curiously illustrated just after I had found that mode of testing the weight. In the first machine which was made for me, the jockey weight was sent to the Standards office, it came back again, was placed on the machine, and then this test was applied, and the 56 lbs. would not balance the weight at a leverage of 40 to 1. It was found that, somehow or other, the weight had been wrongly adjusted. There are four little rollers on which the weight moves, which, when the weight is on the machine, are fixed. When it is off the machine, however, the four little rollers are loose, and the officer at the Standards office, in adjusting the weight, had thought fit to leave those four little rollers out of the calculation, and the weight had been made wrong. That shows that even in so simple a thing as getting the weight adjusted to one ton, there is a possible error if you do not test it afterwards. That is the first piece of calibration.

The next is to test whether the fulcrum distance agrees with the unit length taken on the scale, to determine whether you know rightly the leverage of the machine, that is, the length between the fulcrum and the shackle. It is best to work with rather small weights. The most convenient way of doing it is to have a special one ton weight constructed, a rather long thin one, which can be hung in the shackles of the machine. This one ton slung in the shackle ought to balance your already tested ton weight, at the first scale distance on the scale, or what is still more accurate, the ton weight ought to balance a 56 lb. weight at a leverage of 40 to 1. In that way you can test whether the knife edges are adjusted rightly to the exact distance which is taken as the unit of the scale. The fulcrums are adjusted in that way first of all, and when once adjusted, set pins are put in which prevent them moving. But the test of the fulcrum distance is one that ought to be applied to any testing machine from time to time.

Now there is a third test which has only occurred to me lately, and which is also not without some importance. In machinery of this type the lever itself is very large and very heavy. It weighs nearly four tons, and there is a jockey weight weighing another ton, which is placed on the lever. You are dealing, therefore, in this movable weighing part of the machine, in machines of this type, with very large and very heavy weights. The whole movement of the lever in testing is not very large. In the machines I use the whole movement of the lever is through an arc of not more than about 1°. But even in so small a movement of the lever there will be an error introduced if the centre of gravity of the jockey weight and that of the lever does not coincide with a line drawn through the knife edges. If the centre of gravity of the jockey weight is below the line drawn through the knife edges, then the pull on the specimen will decrease as the lever moves downwards, and if the centre of gravity of the jockey weight is above that line, the pull on the specimen will increase as the lever moves downwards. One can test that very easily by placing in the shackles one of the ordinary suspended weighing machines, that of Mr. Duckham, for instance. I used a suspended weighing machine which weighed one ton. That was first balanced by the jockey weight with the lever horizontal, afterwards with the lever inclined upwards or downwards. It did not matter very much whether the suspended weighing machine was accurate or not in weighing a ton. I only wanted to get what the variation of the pull was with the movement of the lever. I found in my own machine at present that with a movement of the end of the lever three inches upwards and three inches downwards, there is about 12 lbs. error introduced by the movement of the lever in the pull on the specimen. Of course 12 lbs. is practically an unimportant quantity in most testing, but it is a point which ought not to be quite overlooked. It would be possible, in a badly adjusted machine, to introduce a very much larger error than that in the movement of the lever, even through a comparatively small arc. It is quite possible to correct the error due to the position of the centre of gravity of the lever and weight, and to render the lever, if required, perfectly neutral.

Now I come to speak of some other machines. First of all I will speak of what is known as the Werder machine, which is used in almost all the large Polytechnic Schools in Germany. The Werder machine was designed for the Railway Commission of Bavaria, about 1852, and a number of machines of the same size and the same pattern have been made since. The Werder machine is a horizontal testing machine, with a hydraulic press and lever arrangement, such as I described last time, but it differs from other machines in this way. By an ingenious arrangement of the press and weighing apparatus these are both brought to the same side of the specimen, and consequently, as the specimen is behind all the important parts of the machine, arrangements can be made for taking in specimens of almost any length you please at a small expense. As a matter of practice in the Werder machines which have been constructed, it has been possible to take in easily specimens of thirty feet in length. Here is a skeleton and merely diagrammatic drawing of the arrangement in this machine (Fig. 8). The ram of

FIG. 8.



the hydraulic press in moving outwards presses against the knife edge, A, on the end of the lever, and there is a second knife edge, B, just above. The specimen, S, is behind, and bears on the cross-head, which carries the knife edge, B. The cross-head pulls against the upper knife edge, which presses against a steel plane on the lever. As the specimen pulls to the right, and pulls the upper knife edge in that direction, it tends to lift the lever, and in the same way the press pressing to the left against the lever knife edge tends to lift that lever. The ratio of the lever arms is the ratio of the distances between those two knife edges to the length of the lever. Suppose a specimen placed in the machine, and by the addition of weights the specimen begins to stretch. As it does so the whole of the cross-head and lever would move a little to the right, and the lever would turn on the lower knife edge, A (Fig. 9, p. 806), and the end of the lever would come down. To bring the lever level again the press is worked, and the press acting on the lower knife edge, A, pushing that to the right, brings the lever horizontal again, the lever then turning on the knife edge, B.

The Werder machine is a machine in which there is only a single lever, and therefore, in which there are only two knife edges to keep in order. It is loaded by placing weights in a scale, C, and as that is a laborious operation, it comes to be a matter of very great importance to make the leverage as large as possible, in order that the weights to be placed in the scale may not be too large. It is desirable to balance the pull of the specimen by a weight as small as possible, and therefore the leverage is made as large as possible. They have succeeded in the Werder machine in making the leverage larger than in any other simple lever machine. It is 520 to 1. They obtain that leverage of 520 to 1 by getting an exceedingly small distance between the two knife edges, A and B. The short arm of the lever in the Werder machine is only 3 mm., or $\frac{1}{8}$ in., and having the short arm only $\frac{1}{8}$ in., a moderate length of lever gives you a leverage of 500 to 1. It is not very easy to understand how so very short a fulcrum distance as $\frac{1}{8}$ in. can be obtained consistently with using very large wide and strong knife edges. Fig. 9, which shows the essential parts of the Werder machine to a natural scale, may assist you in understanding the way in which this is actually managed.

It may occur to you that, with such a very short distance between the two knife edges, a very small movement of the lever, a small rotation of the knife edges on their abutting plates, might sensibly alter the leverage—the fulcrum distance. In the Werder machine, the short arm length is not very big compared with the radius of the knife edges themselves, and a very small movement of the lever would probably alter, by a measurable amount—by 1 per cent., say—this $\frac{1}{8}$ in. distance between the knife edges. It becomes necessary, then, in the Werder machine, to have the very smallest possible range of motion for the lever, and in order to secure that, the lever is not kept in position by merely looking at it to see whether it is horizontal, but a delicate spirit level is placed on the lever, which shows instantly whether the lever is horizontal or inclined. I have no doubt that in that way quite sufficient accuracy is obtained; indeed, I suspect that in no machine in the world has so much accurate work been done as in the Werder

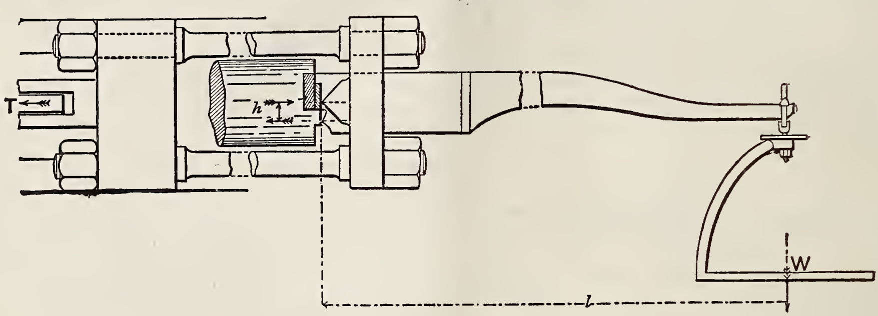
machine, but I think the fact that the lever must be kept level with a spirit level, must make the working of the machine more laborious.

Now in the Werder machine there is the peculiarity that the lever and the scale and the hydraulic press are on one side of the specimen. At any distance further back that you please, there is a fixed tail-piece to which the other end of the specimen is attached. The whole of the important and delicate working parts of the machine are at one end. The tail-piece which is at the other, can be carried on a comparatively rough cast-iron railway which may go back as far as necessary, and which will leave as long a distance as is desired between the front shackles and the back tail-piece. Therefore, in this machine you can get specimens of 30 ft. in length without making the machine extravagantly expensive.

In the Werder machine it would not do to trust to any attempt to measure the length of the short arm in the lever, as it is only 1-8th of an inch long. In the Wicksteed machine there is a 4-inch length in which it is quite possible to measure the fulcrum distance with an approach to accuracy, but that would not be at all possible in the Werder machine. To determine the leverage in that machine, you must therefore have some system of weighing, and there is a subsidiary lever, with a leverage of 10 to 1, which you can use to balance the weight in the scale of the principal lever, and so to determine daily, if necessary, the leverage of the machine. In fact, without a constant re-determination of the leverage of the machine by the aid of a control lever, the Werder machine would not be a safe machine to use.

I have said all that I specially wish to

Fig. 9.

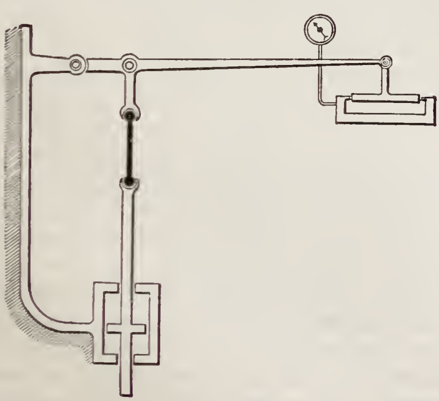


say about lever machines, with the exception of just a reference to one machine which has not yet got to work, but which has been constructed in Berlin, and which, in some respects will be the most remarkable testing machine in Europe. In the great Technical School of Berlin, to which is attached the great testing establishment of the German Government, where they have already several testing machines, amongst them the Werder, they are now constructing a 100-ton machine. I am afraid I could not even now explain all the arrangements which are to be adopted in that machine, but I can give you a broad idea of what is aimed at. In the first place, the machine is a duplex machine, and is really two machines built in one. The right-hand half of the machine is very nearly like the Wicksteed machine, with a number of loose weights, arranged in the way I described last time, in place of the single jockey weight. This right-hand half of the machine is intended to be a testing machine of precision, in which the load on the specimen should always be produced by direct loading with standard weights, involving some trouble, but affording the greatest security that the stress on the specimen is accurately known. Then the left-hand half of the machine is a machine for ordinary rapid testing. It is arranged somewhat in the same way as a Wicksteed machine, with this exception, that the pull on the specimen is principally balanced on a kind of large aneroid box supported by fluid pressure, and the measurement of the fluid pressure on this box gives the stress on the specimen. In order to secure load enough on this side of the machine, there are also fixed weights, so that the aneroid box gives you the difference between the stress on the specimen, and the weight already hanging on the bar. The left-hand side of the machine is arranged so that the whole operation of testing can be carried on

automatically. There are electric arrangements by which the addition of the weights is effected; there is an autographic diagram apparatus which also works entirely automatically. There is a clock which records on a diagram the rate of testing, and there are other arrangements which at this moment I should be rather afraid to describe. The whole idea of this part of the machine is to have a machine not quite of the highest accuracy, but which will work entirely automatically.

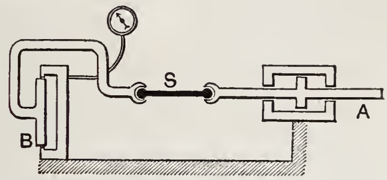
Now of other testing machines there is one class to which I have only incidentally at present referred. In most testing machines the stress on the specimen is produced by pulling at one end with a hydraulic press, and weighing the stress by a weighing apparatus which is virtually a lever and weight, and the dead weight which is placed on the lever measures the stress on the specimen. The handling of weights is in all cases more or less laborious, and, therefore, it has been the object to get rid of the handling of weights by replacing that kind of measurement by the measurement of the stress by fluid pressure. The first machine in which the stress on the specimen was balanced by fluid pressure, so that the load on the specimen could be read off on a pressure gauge, was a machine constructed by Thomasset. It was a horizontal machine, and it had two novel peculiarities, which were both of them exceedingly interesting. The Thomasset machine (Fig. 10) was

FIG. 10.*



the first in which the hydraulic press, which appears in nearly all testing machines, was worked, not with pumps, which work with intermittent motion, but by what is called a quiet compressor, that is by a long ram forced into a cylinder by screws, and sending the water over into the press in a perfectly steady, quiet stream. The quiet compressor which Thomasset used first—invented in fact—has been used since by Mr. Wicksteed and by others. Then the other peculiarity of the Thomasset machine was that the pull on the specimen was balanced by the pressure in a kind of large aneroid box chamber. It is unnecessary to describe further the Thomasset machine, because that got to be replaced in France by a modification, in which the levers were dispensed with. Fig. 11 shows the machine of Colonel Maillard, which is based on the same lines as the Thomasset machine, and which has been used in the French Arsenals, and there is one also in Woolwich Arsenal, the machine they principally use there now for testing steel for guns. In this machine, shown diagrammatically in Fig. 11, S is a specimen to be broken, and

FIG. 11.



that is held between a hydraulic press, A, and a kind of aneroid box, B. With a quiet compressor, or with the pressure from an accumulator, the ram of the press is moved forwards, and puts the pull on the specimen. The specimen pulls through the bent cross-head on to the cast-iron plate at the back. That plate presses on a flexible diaphragm—in the Maillard machine, of india-rubber or leather—which is supported by fluid pressure in the chamber. As the fluid is incompressible, the movement of this diaphragm is extremely small, so that the bending of the diaphragm introduces no sensible error. The pressure in this chamber is given by an ordinary pressure gauge, or it is balanced by a mercury column, and the height of the mercury column gives the pressure. At any rate, here is a machine of comparatively simple type, in which the whole of the lever-weighing apparatus is got rid of. To adjust the machine for specimens of different lengths, the whole of the part B of the machine slides on a bed, its position on the length of the machine being adjusted by

* In the figure the Thomasset machine is shown arranged vertically for simplicity. By making the lever a bent lever the specimen comes to a horizontal position.

a screw. As far as I know, these machines have only been constructed for testing comparatively short specimens; still, even for specimens so short as that, some slight adjustment becomes necessary. Both the hydraulic press and the diaphragm box are carried on trunnions, so that the pull on the specimen is directly along the axis of the machine.

The principle introduced in this machine, first by Thomasset, and afterwards by Colonel Maillard, has been adopted in a number of other machines. The most important machine which acts in that way is the great 450-ton machine which was constructed at the expense of the American Government, which is now at the arsenal at Watertown, in the United States. In 1872, a committee of American engineers was formed to urge on the Government of the United States the importance of a thorough and complete series of tests of iron and steel, and subsequently, by direction of the Government, a Board was constituted for the purpose of carrying out tests of iron and steel, and an appropriation was made of 75,000 dollars for the construction of the necessary apparatus. In 1875, a contract was made with Mr. Emery for the construction of a testing machine capable of weighing 820,000 lbs., and of taking in specimens for testing at least 30 ft. in length. In 1879, the machine was completed, and I think myself it is not only the largest but the most accurate testing machine in the world. Before acceptance by the Board, a long bar of wrought iron, 5 in. in diameter, was broken in the machine at a strain of 752,000 lbs., and without any re-adjustment of the machine a horse-hair was then fixed in the machine, and broken under a strain registered in the machine, of 1 lb. That is rather a sensational kind of test. There is no objection to the machine being so accurate, but that is a degree of sensitiveness, at all events, which is not common in machines. I believe in a very good assay balance, with 1 gramme in each pan, the balance will turn with about $\frac{1}{10}$th of a milligramme, that is $\frac{1}{10000}$th of the load. In a remarkably fine balance which was exhibited at Philadelphia, they found by weighing that the scales would turn with about $\frac{1}{500000}$th of the load in the pans. Now before the Watertown machine was used for actual testing, a lever was arranged behind the machine with a scale-pan, and they weighed various weights with the fluid pressure which was balancing the other end of the lever. In seven weighings of a load of 100 lbs., the greatest difference in the absolute weights, that is, the weights read off by the fluid-pressure apparatus, was $\frac{1}{1750000}$ths of the load. That is, it was three times as sensitive as the remarkable balance that was exhibited at Philadelphia. With weights of 200 lbs. the greatest difference in the aneroid weighing was $\frac{1}{2350000}$ths of the load, that is, 200 lbs. were weighed with a maximum error of less than $\frac{1}{2000000}$ths. The Emery machine is really a machine exactly of the Maillard type, only constructed of very great length, and with a peculiar construction of the fluid-pressure apparatus, which weighs the pull on the specimen, which I will describe very shortly. You have in the Emery machine the hydraulic press pulling at one end of the specimen, and working by an accumulator, and the other end of the specimen pulls on what is termed the hydraulic support, and it is the construction of this part of the apparatus which I should like chiefly to describe. This is a large cast-iron chamber, and the pull on the specimen is brought by a cross-head on the loose top plate. Between the top plate and the chamber there is an exceedingly narrow space, which contains a mixture of glycerine and water. The pull of the specimen (or the thrust of the specimen if you are testing for compression)—the stress—is balanced by the fluid pressure in this narrow space, and it is in the way in which the narrow space is made perfectly water-tight—any leakage, of course, would be fatal—without introducing any frictional resistance, that the beauty of Mr. Emery's machine primarily consists. The water-tightness is secured by an exceedingly thin steel plate, only $\frac{1}{200}$th to $\frac{1}{300}$ inch thick. There is a similar plate fixed to the chamber, and the two ends of these plates come down into a recess where they are bent together, and this space is filled with solder, so that you have here a thin aneroid box consisting of two exceedingly thin circular steel plates, the circumference of which is made perfectly tight, and you have the fluid pressure contained between the two thin steel plates. Now, supposing there is an invariable volume of fluid in this space, the upper plate will rest on the fluid, and any pressure acting there will really produce pressure in the fluid, and the stress on the specimen will be balanced by the pressure in the fluid. To secure that the upper plate shall move vertically, without any side play, which would produce frictional contact between the upper plate and the side of the chamber, there is another of these steel

plates, which is of an annular form, attached at one end to the moveable plate, and at the other end to the fixed plate, and the small movement up and down of this moveable plate can take place by a very minute amount of bending in this annular steel plate. But the plate cannot move sideways, because the annular plate, having a good spring, is flexible to vertical, but opposes horizontal movement.

Now from the chamber which contains the fluid you have to lead off a small pipe to the weighing apparatus. It is a very small pipe, and the water tightness here is secured thus. The gun metal plug through which this fluid passes has its conical end placed against a conical recess. The bearing surface is comparatively short, only about $\frac{1}{4}$ inch, and the fluid pressure inside presses the brass out a little, and expands it, and makes the joint perfectly tight. Now supposing the stress of the specimen is balanced on a box of this kind, how is the fluid pressure measured? Of course one way is to put a pressure gauge on, but Mr. Emery was not content with any pressure gauge kind of weighing, and, therefore, he did this. He connected with this very large box on which the whole pull of the specimen is exerted, another box of exactly the same kind, but very small. When the plate on the large box is pressed down, the corresponding moveable plate of the small box will be pressed up. Then he balanced the pressure on the small or secondary hydraulic support, by a system of levers in which he introduced another ingenious arrangement. Suppose a lever arranged to press on the moveable plate of the small or secondary support; when the stress on the specimen is transmitted by the fluid, the lever will rise. If, then, the lever is brought to balance by weights, there is equilibrium of the forces acting on the system. Further, the applied weights will be less than the stress on the specimen in the ratio of the leverage multiplied by the ratio of the areas of the two hydraulic supports. Since this last ratio can be made easily and exactly as large as we please, the applied weights may be very small.

Obviously the knife edges of the levers must be very perfect, because you have to measure a very small movement of the plate. Mr. Emery was not content with knife edges at all, and substituted for knife edges an exceedingly pretty device. In the place of the knife edges, exceedingly thin steel plates are used, in fact, blades of steel. These are forced on one side into the support, and on the other side into the lever, by pressure four times the greatest pressure to which they are likely to be subjected in working. As the lever moves, these blades have to bend very slightly, but as the whole movement allowed to the lever is exceedingly small, the bending of these blades introduces no sensible resistance Of course if the lever moved a long way, you would have the resistance to the bending of these blades coming in as an important factor, but if the lever moves hardly at all, in a very small arc, then if these blades are thin, they introduce no sensible amount of bending resistance. And whereas if you had a knife edge, the edge would wear, and get broader, and perhaps change the fulcrum distance; the fulcrum distance in the case of these thin steel blades can never change. The thin blades carry much more load than would at first be supposed possible. They are about $\frac{4}{100}$ths of an inch thick. If they are made 4 inches wide, they will carry a load of about 2 tons, and that is about the largest size they require to be made in the weighing apparatus of the Emery machine. The use of that kind of substitute for knife edges runs all through the Emery machine. It was invented for the principal weighing part of the apparatus, but Mr. Emery has used it all through the machine to support any moving part, only of course where he wants a larger movement these blades are made longer and more flexible.

I should like to give you an idea of the delicacy with which the movements of the Emery machine are measured. I have not got the details of the big machine, but the Yale and Towne Manufacturing Company have made some other testing machines of a similar size on exactly the same principle, and they mention that the whole movement of this principal plate in their machine is only $\frac{1}{100}$ inch with the whole range of stress to which it is subjected. So that you see in a movement so small as that, the bending resistance on the steel plates must be infinitesimal.

Now I pass on to describe one more machine, one which has only been recently constructed, and which I think will not be known to many in this country. The Emery machine is a machine constructed for testing long specimens, and very large specimens, and is capable of applying a stress of 400 tons, but it is an enormously expensive machine. It would be very useful to have a cheaper machine which would still be a powerful one, and

one of the neatest machines fulfilling the conditions of being at once cheap and powerful is one which I will now describe, which was constructed for the Union Bridge Company of America. To make the machine cheap, the lever weighing apparatus is dispensed with. The machine consists of two large wrought iron girders, which form the bed of the machine. These girders are 60 ft. in length, and they are supported by cross girders on five masonry piers. At one end of the frame there is a very large hydraulic press. At the other end of the machine is a tail-piece, which can be fixed in a very simple way by bolts at any part of the length of the girders. One end of the specimen is attached to the apparatus, the other is pulled on by the hydraulic press, and for specimens of different length you adjust the machine by bringing the tail-piece nearer or farther from the press, the tail-piece being fixed to the girder by bolts passing through holes in the side of the girders. Now it is the defect of all machines arranged in that way, that what you directly measure is not the pull on the specimen, but the pressure on the ram of the hydraulic press, and the pressure on the ram of the hydraulic press must be greater than the pull on the specimen by any frictional resistance of the leather packing of the press ram. In smaller machines constructed in this way the friction of the packing amounts to 30 per cent. of the load, and as the friction of the packing varies from time to time, it is quite obvious that in that case you cannot get any very accurate testing of the specimen. I do not know whether they have entirely got over that difficulty in this case, but they seem at all events to have very nearly got over it. In this case the hydraulic press is a cast steel cylinder of 4 ft. 3 in. bore and 6 ft. in length, a very large cylinder indeed. It has an effective stroke of nearly 5 ft., so that it can go on pulling even if the specimen elongates, as a very long specimen might do through a very long distance. The back end of this press is left entirely open. The packing is an ordinary gland packing of some kind of hemp rope, in fact, an ordinary soft packing; the packing in this gland is left so loose that, during the action of the machine, a thin sheet of water issues all round the ram between the packing and the side of the cylinder, and you can see the water coming out in a thin stream all round from the back end of the press. By leaving the packing so loose the friction of the ram becomes very small. It is found that when the packing is as loose as that, a pressure of 1½ lbs. per square inch on the piston is sufficient to move it. Now a pressure of 1½ lbs. per square inch on the ram, which is 4 ft. in diameter, gives a load of nearly 3,000 lbs. on a specimen; so that apparently, the maximum allowance to be made for friction in the machine is about 3,000 lbs., and that comes to be not a very large amount in the case of a machine which is capable of testing, and which is ordinarily used for testing, up to about 600 tons. There are two or three ingenious arrangements in detail, especially the arrangements for taking up the recoil which occurs in so large a machine when the specimen breaks, but which I have not time to describe to-night.

Now, passing from testing machines to some specimens which are tested, I have placed some specimens on the table which show their general form, and I should like to point out the construction of some of the shackles for holding specimens. The old way of holding specimens used to be with two pins, placed in two holes along the middle line of the specimen. But specimens prepared in that way are somewhat costly, and they are largely supplanted by another mode. Most plate specimens in these days are held between the two rough surfaces of steel grips, these grips being made with inclined back surfaces, so that the pull of the specimen produces a pressure between the grip and the specimen. With the amount of inclination that these grips have, hardly any specimen will slip. They will hold a plate specimen in a very simple way indeed, and of course the specimen for grips of that kind is very cheaply prepared. The first friction grips which I ever saw used, I am not sure whether they were not the first which were ever used*, were suggested by my old chief, Sir William Fairbairn, about 1860. The bars were round, and were fixed by three taper wedges, fitting like cone keys. The defect of a clip like this is, that you may possibly hold the specimen more tightly on one side than on the other, that the specimen may slip a little on one side and not the other, and that then the stress on the cross section is no longer uniformly distributed, and the specimen breaks by tearing, very much in the same way as when you tear a sheet of paper.

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* Mr. Trueman Wood has pointed out to the author, in the Transactions of the Society for 1837, a much earlier instance of the use of friction grips, by J. Kingston, assistant engineer in the Royal Dockyard, Woolwich. (Trans., vol. 51, p. 133).

Of course in that case you get a false indication of the strength of the specimen. I have always had some objection to these very convenient friction grips. I use them because they are so convenient, and I do not know any other equally convenient way of holding plate specimens, but I have always had some objection to using these grips, and I see that the testing establishments of the German Government are rejecting friction grips entirely in the most accurate testing. If you want very careful testing, I think the only other way is to support the specimen on spherical surfaces, and I have two or three arrangements here of specimens held by spherical surface. The simplest way of doing that is to screw the end, to put a nut on which has a spherical seating, and to hold the specimen then on the spherical seat. Then it can swivel exactly into the line of stress, and you pull it in the fairest possible way. A screw thread is not the best way. The way I like the best is the plan of forming the test bar with collars, under which are placed two halves of a ring having a spherical bearing surface. The Germans first used this form of test bar, and the only objection to it is that it is somewhat expensive to form the test specimens in that way, and that specially constructed shackles are necessary.

Miscellaneous.

PARIS EXHIBITION, 1889.

A Parliamentary paper was published on Saturday last containing correspondence respecting the proposed International Exhibition to be held in Paris in 1889. The correspondence extends over about two years and a half, during which space of time no fewer than four Foreign Secretaries took part in it. In November, 1884, Lord Lyons sent to Lord Granville a report (extracted from the *Journal Officiel*) presented by the Minister of Commerce to the President relative to the Exhibition, calling attention to the fact that the principal reason for fixing the date of 1889 is that it coincides with the centenary of the breaking out of the French Revolution in 1779. In February, 1886, Lord Rosebery made inquiries as to the motive for holding the Exhibition at the particular date mentioned. To this Lord Lyons replied by quoting a portion of the report forwarded about fifteen months earlier. At about the same time M. Waddington expressed to Lord Rosebery some doubts as to the character of the Exhibition, and even as to its being held at all. In the early part of July, however, there was no further doubt; a law on the subject was passed, and 43,000,000f. had been assigned as the sum necessary for the opening, and in August Lord Iddesleigh received the decree and the regulations relative to the receipt of exhibits and other matters. The exhibits were to be in nine groups, sub-divided into eighty-three classes. The notification of these occupies twenty pages, or about two-thirds of the paper. In March last M. Waddington notified to the Government of the Queen the date fixed for the opening of the Exhibition, and solicited their co-operation. "My Government," he said, "particularly value the large participation of Great Britain and with her of all her colonies; on their most valuable co-operation depends indeed in great part the success of this work of peace and industry." If official participation could not be afforded, the French Government would receive with satisfaction the assurance of an official support. In reply to this, Lord Salisbury stated (May 6, 1887) that her Majesty's Government did not propose to avail themselves of the invitation, but would be very happy to afford every facility to exhibitors.

Correspondence.

STATISTICS OF THE PROVINCE OF AIDIN OR SMYRNA.

Among the rare official publications issued in this country, it is gratifying to find one giving some useful information which, if not altogether free from errors, at all events supplies a better basis of information than any private individual can possibly gather from mere heresay. Such a publication has recently been issued in this province in the shape of an Annual "*Salnamé*" of the Vilayet of Aïdin, for the year ending February, 1887. This work is particularly interesting for the census lately taken of the native population (foreigners have not been included yet), the revenue and expenditure, as well as the quantities of the principal agricultural articles produced during the year, and various other useful data which it gives. As the province, or vilayet, is divided for administrative purposes into five sanjaks (lieutenant-governorships), I will follow the official Table of the census, which appears on page 812.

Allowing for the foreigners residing in this province and other omissions, which necessarily must be considerable, considering the primitive way the census have been taken, 148,372; added to the above, this will give us in round numbers a gross total of 1,400,000 souls. Assuming the area of the vilayet to be, as it is generally computed, about 31,000 square miles, this will give us a fraction over forty-five inhabitants to the square mile.

Owing to the great bulk of the Mussulman immigration which still continues from Bulgaria, Roumelia, Thessaly, the Dobruja, Bosnia, and the Herzegovina, the population has increased during

Population of the Vilayet of Aidin.

Names of Sanjaks.	No. of Musulmen.	No. of Greeks.	No. of Armenians.	No. of Jews.	No. of Roman Catholics.	No. of Protestants.	No. of Bulgarians.	Observations.
Smyrna	252,299	121,600	7,894	16,860	1,811	125	128	The population here are all Turkish subjects.
Magnesia, or Manisan	288,285	31,079	3,806	2,003	..	1	331	
Aïdin	173,113	15,152	568	2,011	109	..	..	
Denisly	166,647	2,104	476	..	..	..	..	
Menteshe	129.569	9,667	..	466	..	..	..	
Total	1,099,913	179,592	12,744	21,340	1,920	126	459	
Non-resident Turkish subjects	16,387	7,893	1,072	178	4	..	..	
Total number of each denomination	1,026,300	187,485	13,816	21,518	1,924	126	459	

Total number of native population, 1,251,628.

the last decennium by 25 per cent.; over 50,000 of these new comers have settled in Smyrna.

The police force of this vilayet is composed of, all told, 2,262 men and 114 officers, 2,376 in all, or one policeman to every 589 inhabitants.

Exclusive of customs and the revenues ceded to the bondholders, viz., tobacco, salt, stamps, spirits, &c., which represents fully 60 per cent. of the total income, the revenue of the province was £1,028,516T, and the expenditure £195,639T, which is not bad for a purely agricultural country; but adding customs and the ceded revenues together may be put down at £1,500,000T.

The Press is headed with two Turkish papers, one half Turkish and half Greek, four Greek, four French, one Armenian, and one Judeo-Spanish, all published at Smyrna.

The following are the principal agricultural articles produced during last year:—

Raisins and grapes	1,000,000 hectolitre.
Fresh and dry figs	14,000 kilometric tons
Barley	2,000,000 kiles = (hectolitre)
Wheat	1,500,000 ,, ,,
Cotton	33,000 kilometric tons
Millet	200,000 kiles = (hectolitre)
Sesamy	80,000 ,, ,,
Maize	240,900 ,, ,,
Lupines	130,000 ,, ,,

Olives and olive oil produced during the year was of the value of about 300,000 Turkish liras. The average value of the valonia produced during the year was about £300,000T.

There are many other valuable articles of agricultural produce in the vilayet which are not enumerated in the annual; however, the data given being official, are on that account of interest.

S. Stab.

Corresponding Member Society of Arts.

Smyrna, 27th May, 1887.

Obituary.

Sir Ashley Eden.—The Hon. Sir Ashley Eden, K.C.S.I., C.I.E., died at his residence, 31, Sackville-street, London, on Saturday, 9th inst. He was born in 1831, the third son of the third Lord Auckland, some time Bishop of Bath and Wells. He spent his boyhood at Rugby and Winchester, and entered Haileybury when that institution educated young men who had already obtained nominations for the India Civil Service. This service he entered in 1852, and was employed in suppressing the Santhal rebellion in 1855. In 1861 he was appointed special envoy with the Sikkim expedition, and then for ten years was Secretary to the Government of Bengal and member of the Legislative Council, during which time he went on a special mission to Bhotan. From 1871 to 1877 he was Chief Commissioner for Burmah, and then for five years Lieutenant-Governor of Bengal. In 1882, just before Sir Ashley Eden left India, a public banquet was given to him, and a resolution was passed at a public meeting acknowledging his distinguished career of thirty years in India, and especially his administration of Bengal. Since 1882 he served as a member of the Council of the Secretary of State for India. He was made a Companion of of the Order of the Star of India in 1874, a Knight Commander of the Order in 1878, and a Companion of the Order of the Indian Empire in the same year. Sir Ashley Eden was a member of the Society of Arts, and presided at several of the evening meetings of the Society, the last occasion being in January of last year, when Mr. J. George Scott read his paper on "Burma" before the Indian Section.

Journal of the Society of Arts.

No. 1,809. Vol. XXXV.

FRIDAY, JULY 22, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, the 18th inst., at their first meeting after the annual election, the Council elected Sir Douglas Galton, K.C.B., D.C.L,, F.R.S., as Chairman for the ensuing year. The various committees were also re-appointed.

Proceedings of the Society.

CANTOR LECTURES.

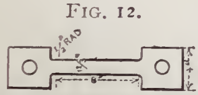
MACHINES FOR TESTING MATERIALS, ESPECIALLY IRON AND STEEL.

By Prof. W. C. Unwin, F.R.S., M.I.C.E.

Lecture III.—Delivered April 4, 1887.

At the end of my last lecture I referred very briefly indeed to the mode of holding specimens in testing machines. The old method of holding specimens was by means of pins, as shown in Fig. 12. If the holes for the pins

Fig. 12.

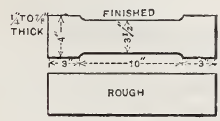


French Admiralty Test Bar

are exactly in the axis of the bar, and if—which I think has been too much neglected—the pin itself is of so large an area that there is not much distortion of the hole round the pin during the process of testing, that is a perfectly satisfactory mode of holding test specimens. Sometimes in testing large specimens, when the pins would have required to have been large in diameter, there has been substituted for the single pin a series of six or more pins; but that method is not quite satisfactory. Some specimens tested in this way break through the enlarged ends at sections very much greater than that in the middle of the bar, showing that the distrition of stress by the set of pins is irregular.

Specimens of the form shown in Fig. 12 are somewhat expensive to prepare. Hence it has become common with plate specimens to use shackles with wedge grips, and then the test bars have the form shown in Fig. 13. The

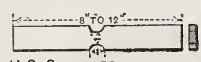
Fig. 13.



recessed part is best cut out by a milling machine.

With materials which are at all brittle the test bar must be recessed, but with ductile materials it may often be left parallel without much risk of fracture occurring inside the shackles. Nevertheless, the recessed form is best, and the recessed part should, if possible, be eight or ten inches in length. The form shown in Fig. 14 is a bad form, giving higher

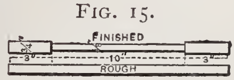
Fig. 14.



U.S. Standard

tenacity and less contraction of section than ordinary test bars. This form was at one time stated to be the standard form in the United States, but no doubt is now abandoned. Fig. 15 shows the form of round bars for friction grips with V-shaped recesses.

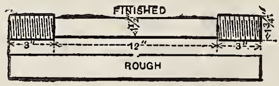
Fig. 15.



I spoke last time sufficiently about the possibility, in holding these specimens in wedge grips, of getting the line of the resulting stress not in the axis of the bar. A large number of specimens now are prepared with a screw

thread chased on the ends (Fig 16), a nut screwed on which is held in some form of clip. That, especially if the nut is made with a spherical seating, is much more satisfactory than the methods I have already described,

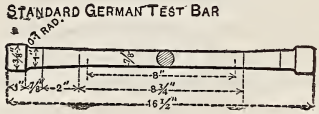
Fig. 16.



but it has this slight objection, that you are not quite sure of the accuracy of your screw threads, and it is not quite certain that in that way you get a perfectly fair hold on the specimen. Probably, the best form of specimen of all which can be used for tension specimens is that adopted as the official German test bar, which is shown in Fig. 17. In German official

Fig. 17.

Standard German Test Bar



testing they adhere in all the proportions very strictly indeed to these dimensions, whatever the size of the plate or bar that has to be tested.

Measuring Instruments.

Next, as to measuring instruments used in testing. Measuring instruments are used in the engineering laboratory primarily for measuring the specimens themselves, and, secondarily, for measuring the deformations of specimens under test. For ordinary measurements of length, measurement of ultimate stretch for instance, we use graduated straight-edges, and those very nice steel straight-edges which are graduated in America by Messrs. Brown and Sharpe are admirable; they are graduated to $\frac{1}{100}$th of an inch, and are thoroughly trustworthy to any limit to which they can be read. For measuring sections of the specimen which has to be, or which has been, tested, we use instruments of greater accuracy, because a very small error in measuring the diameter or width of the test bar makes a good deal of error in the result of the test. I have placed here two forms of the ordinary instruments used. There is the ordinary micrometer screw calliper, in which there is a very finely cut micrometer screw. The specimen is placed between the jaws, and bringing these into contact with a certain degree of pressure, the calliper reads off the diameter of the test bar. About this, as about all screw micrometric instruments, the chief difficulty is in getting uniform pressure on different test specimens, because by using a little force you stretch the jaws, and you get a difference of reading. Some of these micrometers are made with devices, such as spring ratchets, in order to secure, as far as possible, uniform pressure on different specimens. My feeling is that, after all, you do better with your fingers; that ratchets, and so on, are only contrivances for getting round a difficulty which can be got over better by a little skill of hand. For larger specimens sliding Vernier callipers are used. There is one of Brown and Sharpe's steel callipers here. This has a fixed and sliding jaw, and one of the jaws carries a Vernier by which the dimensions of the specimens can very easily be read to the $\frac{1}{1000}$th of an inch. I do not think you can go further than this with any simple Vernier. You will notice about these instruments that in order to prevent any bending of the jaws, which is one of the difficulties in most forms of calliper, the jaws are made very short. That is sometimes an inconvenience, but it adds to the accuracy of the instrument, that you can produce very little bending by any reasonable amount of pressure. Instruments of this kind, at least as accurately made, are manufactured by Mr. Holtzapfel, and by Messrs. Elliot, and I have also used a good deal a Vernier calliper with longer jaws, for purposes where these are necessary, made for me by Messrs. Breithaupt, at Cassel. Of course a slight stage further in accuracy of measurement might be gained by using a fixed instrument like Whitworth's $\frac{1}{1000000}$th measuring machine, though for ordinary specimens the measurement to $\frac{1}{1000}$ of an inch in linear dimensions is accurate enough.

The instruments for measuring thus far described are simple in construction, and are largely enough in use to be considered ordinary commercially made instruments. The instruments which are used for measuring the deformation of a specimen during the test are of a more refined character, and present much more difficulty. In almost every experiment on the elastic properties of materials it is necessary to measure the strain or deformation which corresponds to the different stresses. Thus in tensile tests, the elongations are measured, and in torsional tests the twist is measured, in bending tests the deflection is

measured. In ordinary commercial tests of the quality of ductile materials, such as wrought iron and steel, only the ultimate permanent deformation is measured; and since, in such cases, that is in the case of ductile material like wrought iron and steel, the ultimate elongation or deformation is very considerable, comparatively rough measurements are quite sufficient. If a soft steel bar is broken by tension, the permanent stretching of an 8-inch length—the usual test length—may amount to as much as 2 inches, and the error of even $\frac{1}{50}$th of an inch would be only 1 per cent. of the elongation, and that is an accuracy quite sufficient for practical purposes. For somewhat more rigid materials, such as thin wrought iron plates, the extension is less, and it is desirable to make the measurement more accurately; but even in that case no very refined measurement is practicable, because of the difficulty of fitting the pieces together after they are broken. Hence, for all measurements of the strain in ductile materials during the progress of testing, after the elastic limit is passed, a somewhat rough measurement must be taken to be sufficient. But it is altogether different when the strains within the elastic limit require to be observed. A mild steel bar, say 10 inches long, would stretch less than $\frac{1}{100}$th of an inch when the stress reaches the elastic limit. Measuring this quantity with an accuracy of 1 per cent., the measurements must be so delicate that no error of measurement must be permitted to exceed $\frac{1}{10000}$th of an inch. Measuring with degree of accuracy is much more difficult than is commonly supposed. In standard bars intended expressly for checking length measurements, and made of the most suitable form, it is not difficult to ensure accuracy to even so small a limit of error, but in measurements of elongation of test bars, the form of which depends on considerations other than their suitability for measurement, it is very much more difficult to make an accurate measurement. Hence, in selecting instruments for determining strains, the precise object of the measurement has to be kept in view, and no instrument is equally suitable for measuring small elastic and large permanent deformations, at least of very ductile materials. For some purposes an instrument is required delicate enough for very refined measurements, and then the range of measurement is in general very limited.

I will take for the present only the case of a bar which is subjected to tension, and of which the elongation is to be measured during the test; the simplest way of measuring the elongation, and one in many cases very useful, is to employ a beam compass and one of Brown and Sharpe's graduated scales, and in measuring the ultimate elongation of the bar after it is broken, if the pieces are put together, and the distance between two slight centre punch marks is taken with a beam compass, and measured on Brown and Sharpe's scale, that is quite accurate enough. Now, quite twenty years ago, I began to try and measure elongation with a greater accuracy than could be obtained with a beam compass and graduated scale. There existed at that time an instrument which had been used chiefly for measuring the deflection of cast-iron bars, which was called the wedge gauge. The wedge gauge was simply a very long triangle of metal, with perhaps 1 inch of rise to 10 inches of length, and it was graduated along the edge. I do not think at the moment I used it then, it had been used for measuring elongation, but it occurred to me to be a very simple instrument for that purpose. On the test bar were clipped two pieces of metal, which were arranged to have a very narrow bearing surface, and to stand off the bar. You introduced the wedge gauge initially before the bar was strained, between the points of the clips, and took a reading. Then the bar was gradually stretched and you took successive readings, and in that way it was quite possible to measure $\frac{1}{1000}$th of an inch. I think, provided one could absolutely have depended on the wedge gauge, one could have read to something like $\frac{1}{5000}$th of an inch. One difficulty is that it is extremely difficult to get two sides of a thin wedge of that kind perfectly true, and unless you verify the value of the divisions by independent micrometric means, the correspondence of these divisions with equal increments of the height of the wedge is not to be depended upon.

Next to that very simple arrangement for measuring elongations, an instrument which has been very much used is the screw micrometer. The screw micrometer is virtually a wedge gauge wrapped round into a spiral thread. Two clips may be fixed on the specimen, at a known distance apart; one carries a micrometer screw. By turning this screw it can be brought to bear on the lower clip. As the specimen extends it must be turned further, the amount of turning read off on a graduated head giving the elongation. Such a screw can be made of a very fine pitch, and as the

head on the screw can be made pretty large, you can apparently read to a very great degree of accuracy with a fine thread screw of that kind. If the screw has 50 threads to the inch, and the head is large enough to be divided into 100 legible parts, you read directly to $\frac{1}{5000}$th of an inch; but as you may make the head large in diameter in proportion to the screw, it is quite easy to make the parts into which the head is divided small enough to read to $\frac{1}{4}$ of a division, and that gives you a reading to $\frac{1}{20000}$th of an inch. But in using a screw micrometer much difficulty arises. The screw does not directly measure the elongation of the bar, but the distance to which two clips fixed on the bar are moved apart by the extension of the test bar. In the first place it is a little difficult to secure always the same pressure of the screw on the abutment up to which it is brought before you take a reading. That difficulty has been got over, sometimes, by making the screw and abutment parts of an electric circuit, so that the moment of contact is determined by the deflection of a needle or the ringing of a bell. But that is not the most serious difficulty, which is one not at all sufficiently taken note of, namely, that these micrometer screws have not quite so great a uniformity of pitch as they are assumed to have, and it is a matter of very considerable difficulty and labour to determine the errors of any given micrometer screw. But, nevertheless, the measurement of the minute elastic extensions of a bar by means of micrometer screws would still be a comparatively simple matter if further difficulties did not arise out of the practical conditions of testing. The micrometer screw can only be directly used to measure the distance between two clips fixed on the test bar, and it is a first condition that these clips must be so attached to the test bar as not in the least to indent its surface or injure its form. Now, in proportion to the magnification you get on the milled head, so is the force exerted at the point of the screw greater than that put on in turning the screw by the fingers. Obviously, then, putting the pressure of a few ounces on the micrometer head produces a pressure of several pounds on the clips which form the abutment of the screw, and that pressure tends to disturb the position of the clips on the test bar. In many of these instruments the stability of the clip on the test bar has been obtained by making the clip fit for a considerable distance along the test bar. Of course, if your two clips have a considerable length of bearing, the pressure of the micrometer screw will not much disturb them, but that gives rise to another difficulty. You want to know the elongation of a certain definite length of the test bar. If clips of this kind are used, it becomes uncertain what is the length of the test bar, the elongation of which is measured, for if the clip bites the hardest at the bottom edge, you are measuring the extension in one length, and if the bite is hardest on the top edge, you are measuring the extension in another length, and the real distance which is elongating carrying the clip with it becomes quite an uncertain quantity. I will show you in a moment how that difficulty is got over, but I will first point out a modification due to Professor Thurston, which gets over part of the difficulty. Professor Thurston extended the clip on both sides of the test bar, aud took simultaneous measurements on the two sides. That is a very considerable improvement on the ordinary single micrometer screw, because if one screw disturbs the clips in any degree, it diminishes the reading on the one side as much as it increases it on the other, and the mean of the two readings is likely to be the true reading independently of any movement of the clips. But there still remains the difficulty about fixing the clips on the test bar in such a way that the length in which elongation is measured is accurately defined.

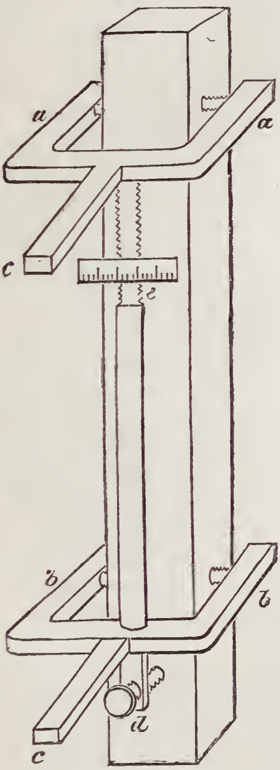
Some years since the author adopted for round bars a form of clip which succeeds perfectly in the double function of defining accurately a certain length of test bar which elongates, and at the same time of being very rigid in position relatively to the axis of the test bar.

Consider a clip placed on a cylindrical test bar. Let the clip be so arranged as to grip the test bar on three sides. Then if on one side the clip has a flat surface, on a second side a knife edge at right angles to the axis of the test bar, and on the third side a pointed set screw, the test bar will be held between a plane, a line, and a point. With that arrangement the clip holds its position very rigidly, and yet the distance between the knife edges of two clips is very accurately defined. You will see that, in a more or less degree, the same plan is carried out in some other clips exhibited. Here are two clips of just the kind I have been describing, in which the clip holds its position between a plane, an edge, and a point.

Now, having got a satisfactory arrangement for attaching temporary clips to a test

bar, the distance between these could be well ascertained during a test by such an arrangement as that of Professor Thurston. The distance between two opposite points of each clip, one on each side of the test bar, could be ascertained by micrometer screws, and some electric or other arrangement could be adopted for determining the moment of contact of the micrometer screws with the clips. But all this involves complication. At the least it involves two readings for each elongation, the average of which is to be

FIG. 18.



taken for the true reading. It appeared to the author to be inconvenient to have always to take two readings, and to avoid this he contrived the instrument shown in Fig. 18. In this instrument with one reading the same accuracy is obtained as by taking two readings on opposite sides of the bar. In fact, the average extension of two sides of the bar is given directly, the averaging being done mechanically.

The clips are simply two forked clips, which hold the bar on its middle plane. If those two clips can be kept so that they hold always exactly the same relative position to the axis of the bar, so that the axis of the bar being vertical these clips are always horizontal, obviously the difference between the middle points of these clips will be the mean of the extension of the two sides of the bar. So that only one micrometer screw is required, and that is placed so as to measure the distance between the middle points of these two clips. There is only required some arrangement whereby these clips can be at once adjusted to hold always the same position with reference to the axis of the test bar. That is easily secured by placing on the extended arms of the clips two sufficiently delicate levels. The mode of measurement is this. These clips are fixed on the specimen, the lower one is adjusted until it is exactly horizontal by the spirit level and levelling screw below. Then the upper clip is adjusted to be exactly horizontal by means of the micrometer screw. Then when the load is placed on the specimen, and it has extended by say some $\frac{1}{10000}$th of an inch, the lower clip is then again adjusted level, and the upper clip is adjusted level by the micrometer screw, and the difference of readings gives the extension. The levels are just delicate enongh, and the reading of one division of the micrometer corresponds to $\frac{1}{10000}$th of an inch.

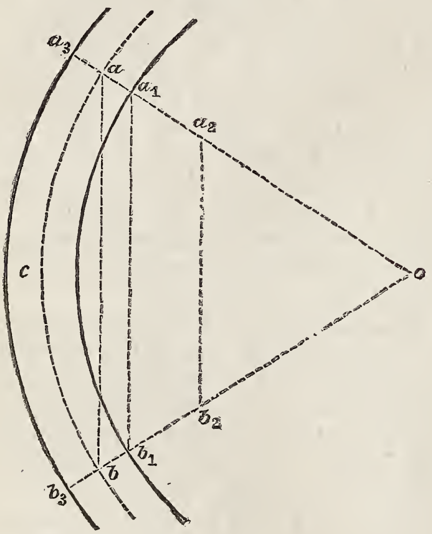
There is one reason, the importance of which has only sufficiently occurred to me of late, but which I believe Bauschinger observed long ago, why the double measurement of a test bar is almost essential in every accurate measurement. It is not only the possible disturbance of the clips between which you measure, which leads to error in the measurement taken on one side only of a test bar. It is extremely difficult to get a test bar which is absolutely straight to begin with, and even if it is absolutely straight to begin with, unless it is held in quite a perfect way in the shackles of a testing machine, one side of it will extend a little more than the other, and the bar will become curved during the test. The straightening of an initially curved bar, or the curving of an initially straight one, introduce errors in the measurements of very considerable amount.

If the measurements could be made at the axis of the bar, the errors of this kind with any amount of curvature likely to occur would not be very serious; but this is of course impossible. The best that can be done is to measure at the surface of the test bar. But, in straightening, the surface of the bar on one

side lengthens, and on the other shortens, and thus introduces a not inconsiderable error of measurement. If, as in many forms of elongation measuring apparatus, the measuring points are two inches or more from the axis of the bar, the errors become very large relatively to the elongations to be measured.

Let Fig. 19 represent a bar bent in the plane of the paper, the centre of curvature being *o*. Then, if measurements could be made on the axis of the bar, between the points *a b*, the straightening of the bar would introduce an error equal to the difference of the length of the chord *a b* and arc *a c b*. With any amount of curvature likely to occur in a test bar, this error would not be very serious. Generally,

Fig. 19.

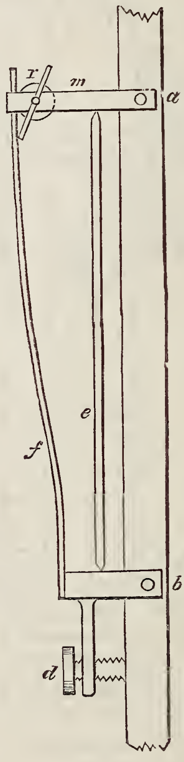


however, the best that can be done is to measure the distance between points a_1 b_1, on the surface of the bar. Then, since by straightening the lines *ao bo* become parallel, the error introduced is the difference between a_1 b_1 and the arc *a c b*; and this is much more serious. Most commonly, however, measurements are made between points on clips fastened to the bar at one or two inches distance from its surface, such as a_2 b_2. Then the error introduced by straightening is the difference between a_2 b_2 and the arc *a c b*; and this may be a serious error, even with a very small amount of initial curvature.

If simultaneous measurements are taken of a_1 b_1 and a_2 b_2, and a_3 b_3, the mean of these will have no greater error than the measurement of *a b*. That is, the mean of measurements on two sides of the bar reduces the error due to initial or induced curvature to the same amount as a measurement actually made at the axis of the bar.

Bauschinger has all along got over the error due to curvature by using two mirrors and rollers, one on each side of the bar, and taking two readings, and I do not suppose any readings of extensions have been made hitherto which surpass in accuracy the readings he has made with the double mirror and rollers. Still, it is an inconvenience to have to adjust two

Fig. 20.



instruments, and to take two readings for each extension. On the table I have an instrument, shown diagrammatically in Fig. 20, in which I have tried to combine the accuracy of Bauschinger method with greater facility of adjustment and greater rapidity of work. In this, two clips are fixed on the middle plane of the test bar, as in the screw micrometer. The lower clip is supported by a set screw, *d*, adjusted to the test bar surface. There is a stay bar, with knife edges, which forms a distance piece between the upper and lower clip. The upper clip carries a roller and

mirror, x, the axis of which is at the same distance from the knife edges of the stay bar as the set screws of the clip attaching it to the test bar. A touch-piece or finger, f, attached to the lower clip presses on the roller. If the bar extends, the roller approaches the lower clip by an equal amount; it turns against the finger, f, and the amount of rotation is read by a telescope and scale. This instrument will easily read to $\frac{1}{100000}$th of an inch. The roller being at the centre of the clip, its movement is the mean of the elongations on the two sides of the test bar.

The most accurate means which can be employed for the mechanical magnification of an extension is to use a hard and accurate roller turning on a hard and accurate plane. Further, let a mirror be attached to and rotate with the roller. Let a scale be observed by reflection on the mirror through a telescope. Then as the roller and mirror rotate, the scale divisions pass over a cross wire in the telescope. It is easy to arrange that the distance of the scale from the mirror should be as large as we please. Then extremely minute rotations are easily observed without introducing any uncertainty or inaccuracy. We use, in fact, an optical lever arm which is weightless and frictionless. It occurred to Bauschinger years ago to use this roller and mirror method of magnifying extensions. Also Bauschinger appears to have considered the error liable to be introduced by initial or induced curvature of the test bar.

In Fig. 20 there are clips clipping the bar on the two sides, and the roller is placed at the middle of the clip, so that a single roller here effects the same purpose as the double roller in Bauschinger's instrument Some of you may perhaps know that the same method, carried out in a rather different way, has been used by Mr. Stromeyer quite independently. He uses a roller and a finger, and to prevent any discrepancies due to curvature he was led by his own observations to use two rollers, one on each side of the bar. Instead of using a mirror, however, Mr. Stromeyer proceeded a little differently. He has placed on the roller a finger moving over a graduated scale. Now the finger, of course, can only be made some eight or ten inches in length, and the measurement in that case would not nearly be fine enough unless the diameter of the roller is greatly diminished. Mr. Stromeyer pushes the possible diminution of the diameter of the roller, I think, to the furthest possible limit, for he has used for his roller piece wire only $\frac{1}{200}$th of an inch in diameter. With a roller so small as that, of course, you get very great magnification of the extension. A roller only $\frac{1}{200}$th of an inch in diameter revolves through a considerable angle, and with a very moderate length of the finger you can accurately read an extension of $\frac{1}{1000000}$th of an inch. But I think in that case you are getting into difficulties of another kind. It is very difficult indeed to get a wire roller so very small either perfectly straight or perfectly cylindrical, and I fancy Stromeyer has come to the opinion that using a roller of larger diameter is on the whole better, although in that case the magnification is less.

Compressive and other Tests.

I have now to speak shortly of some other modes of testing. Hitherto I have spoken almost exclusively of the ordinary tests made in tension. Probably 999 out 1,000 tests are tensional tests; nor are there any other exact tests which are made quite as carefully as tension tests. They are, as it were, the standard or normal tests. But, obviously, nearly all building materials at any rate are used not in tension but in compression, and it is rather from defect of apparatus than for any other reason that, in testing such materials as Portland cement, tension tests have been resorted to to discriminate the quality of the cement. Here are some small pieces of Port land and other cement tested by tension. No doubt these tests, introduced originally by Mr. Grant, have done great service in improving the quality of Portland cement, for I was told by one of the largest users of Portland cement in this country that he now gets tests as good with a 1 square inch test piece as a few years ago he used to get with a 2 square inch test piece. But Portland cement is used in building in compression and not in tension, and the cement which is strongest in tension is not always the strongest in compression. If one sample is 25 per cent. better than another in tension, you cannot infer that it would also be 25 per cent. better in compression. Therefore, it seems to me that probably in the course of time we shall come to testing building materials, at any rate, far more by compression. Now in compression tests one is landed in one or two difficulties. In compression testing you are obliged to crush the specimen between slides, which have to be drawn together towards each other, and in order that they may come towards each other, keeping their faces perfectly parallel, the shackles

must be guided by some form of slide. Of course, in introducing these guides, some slight element of friction is introduced, which need not be very serious. But then comes another point. Building materials, such as stone and blocks of concrete, are difficult to obtain with perfectly parallel faces. If you place a block which has not parallel faces between the parallel faces of a shackle, the whole of the pressure of the testing machine will come on one edge of the blocks and the specimen will crush with a pressure far too low. The steel faces cannot cant to accommodate themselves to the block, and even if they did so, you would not secure perfect equality in the distribution of the pressure over the surface of the block. The first thing one can do to a little modify the error likely to come from the imperfect form of the test block, is to use between the shackles and the test specimen a ball-and-socket joint. I have put one on the table, which is placed between the shackles and the test specimen, which accommodates itself so as to press very nearly equally, even if the block to be crushed is not a cube. Of course, as the pressures get larger, the friction of the spherical joint must be very considerable, and then the adjustment is only an imperfect one, but you will find this slides pretty easily. That gets rid, to some extent, of the difficulty, but it is much better to have a block with the surfaces as parallel as you can get them. You will notice that that has been obtained in some of the test blocks by preparing the surface before testing. I have found that although any ordinary quick setting cement like plaster of Paris, or Parian cement, is not very strong in itself, it is quite strong enough when spread over the block in a very thin layer to resist the highest crushing pressure I could put on the blocks. I have had blocks of this kind which had initially more or less broken surfaces, but when they were prepared with a thin layer of plaster of Paris, they would stand a compression of something like 100 tons on an area of about 6 in. square, and even under that very large pressure this thin layer of Parian or plaster of Paris does not at all crack or crush. You will see, even on this rough brick, how well the plaster of Paris has kept its solidity. Using plaster of Paris, or Parian cement, or some quick-setting cement of that kind, it is quite possible to prepare surfaces on rough bricks or stones which shall be perfectly parallel before you test them. Then, having parallel surfaces to begin with, and a ball-and-socket joint, I think you can get compression tests which are scarcely inferior in accuracy to tests by tension. There are some specimens of crushing tests on the table in which you will see the way in which most building materials give way when they are crushed. They do not actually crush; they shear on the faces which are inclined at an angle approximately of 45° to the sides; they shear into a set of pyramids six in number. On the table is a cylindrical block which has gone very much in the same way, only the sides have gone into a greater number of pieces.

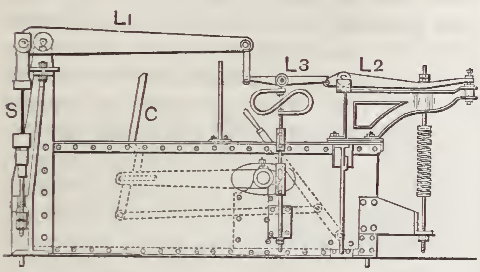
I will now just direct your attention to an instrument for measuring the compression of these building materials under test. The same principle is carried out as in the instruments for measuring extensions. There are two clips, which have a bearing on two sides of the test block. The upper clip rests upon a steel face attached to the lower clip, which is attached to the test block with four screws, so that it holds a fixed position with reference to the bottom of the block. There is a leverage of about $2\frac{1}{2}$ to 1. As the block compresses the upper clip is lowered a little, and turns on the knife edge, and the free end or lever rises a little relatively to the lower clip. With a diamond scratch across the faces and a microscope micrometer, it is quite easy with this instrument to read compressions of a stone block even under a pressure of a single ton per square inch placed on it.

Tests of Endurance. Repetition of Loading.

I should like, before concluding, just to speak of one kind of testing which is likely to be no little importance in considering the working stress to which materials should be subjected. Fig. 21 (p. 821) shows one of the machines used by Wohler, which has now become of very great importance. It occurred to Wohler that some explanation ought to be found of the fact that we never in practice use working stresses which even approximate towards the breaking stress of the material. We do not load a boiler to more than one-eighth of the breaking stress of the metal of which it is made. In the case of shafting and other parts of machinery, the working stress is even a smaller fraction of the breaking stress. It occurred to Wohler to seek an explanation of that by subjecting bars to nearly the same kind of action to which they are subjected in actual work. He

took bars and subjected them to a certain definite stress, not placed on them once, but over and over again, and after a sufficient number of repetitions, he found that bars of all metals broke with stresses very considerably less than their statical breaking strength. To insure perfect accuracy in the experiments, it is necessary to secure that for periods of weeks, months, and even years in some of Wohler's experiments, exactly the same stress should be applied to the bar over and over and over again. This is secured in all Wohler's machines in an exceedingly ingenious way. The machine shown in Fig. 21

FIG. 21.



is the type of a series of machines he used for tension, torsion, and bending; for he tried bars under all these kinds of stresses. The test bar, S, is to be subjected in this particular case to tension. The tension is put on it by an ordinary lever, L_1, like the lever of an ordinary testing machine. The load is placed on the bar by a connecting rod, C, coming down from a cam on a revolving shaft, and depressing the lever. As it works up and down, it pulls on a shackle, and that shackle pulls on the end of the lever, and put the stress on the test bar.

Now, if you had only that arrangement, it would become necessary to fix very exactly indeed the stroke of this lever, to put exactly the right stress on the test bar. In fact, it would be necessary to fix it more accurately than I think it would be possible to fix it. Wohler gets over that difficulty in this way. The long shackle which is driven by the engine, and which makes a stroke about twice a minute, pulls on the middle of a secondary lever, L_3. One end of this secondary lever is carried on a third lever, L_2, which is held down by a long spiral spring. So long as the pull of this shackle on this secondary lever does not exceed a certain limit, the long lever gives way, and the tension comes on the test bar. If the pull exceeds a certain amount, instead of pulling any more on the specimen, it lifts the spiral spring, and you can adjust the tension of this spring by trial until you have exactly the desired stress on the test bar. So long as the spiral spring keeps a constant elasticity, that insures an absolute constancy of tension on the test bar, and if the experiment is going on, as some of these did, for two or three years, it is quite possible every month or two to stop the experiment in order to test whether the spring is giving exactly the right stress. In that way, I have no doubt that the experiments are made with quite perfect accuracy.

Miscellaneous.

WINE PRODUCTION IN CATALONIA.

Consul Scheuch, of Barcelona, in his last report, says that the value of wine in Catalonia being generally based on the deepness of the colour, bruising by the feet is preferred to any wine press, however perfect, for besides the advantage the first method has over the second, of more perfectly airing the must, foot-bruising breaks up more completely the outer skin of the grape in which the colouring matter is contained. The pressing is done either with bare feet, the men walking for hours in a small circle, which is preferable, as neither the seeds of the grape, nor the stems, which contain a large amount of tannin, are broken, or with hemp sandals made specially for the purpose. If wooden fermenting vats are used, the bruising is done in tubs, from three to five feet wide, and two feet high. When the pressing is finished, the juice and stems are taken to the fermenting vat, either by running them off from the press direct, or in dippers. When the vats are of masonry, the pressing is done on a platform of loose boards on the top of the vats, the must running into the vats through the cracks. The stems, seeds, and skins are also let down into the vats, by raising one of the boards, care being taken that they shall spread out uniformly on the bottom of the vats, for which purpose the boards are lifted successively, one after another. Although foot-bruising is preferred to the use of any mechanical presses, the latter are frequently used, two descriptions being manufactured in Barcelona, and many of English, German, and Belgian make are offered for sale. Must undergoes two fermentations, one rapid, the other slow; the first takes place in the vats after coming from the press. In Catalonia these vats are generally made of wood, while in other parts of Spain earthen vats are commonly used. The wooden vats are easily set up

and cleaned without difficulty. They are filled to within eighteen inches of the top, thus avoiding the spilling of the wine. The size of these vats differs, being proportionate to the quantity of the crop, for if the fermentation is to take place simultaneously in the entire liquid, the vat should be able to be filled in twenty-four hours. In Catalonia the wines are more appreciated the drier they are, that is to say, the less there is of unfermented sugar, and the greater amount of colouring matter they contain. After the rapid fermentation, the wine is poured into casks, where it undergoes the slow fermentation. In many parts of Catalonia, the pouring of the wine into casks is done with pails, and the wine often becomes sour, or loses aroma by being in contact with the air too long. Pumps, syphons, and sail-cloth hose are daily coming into greater use. The slow fermentation in the casks, which lasts six months, is the last process, and the wine is then fit for market. About one-fourth of the wine produced in Catalonia is consumed in the country. The remainder is exported to France and South America, with a small quantity to Russia, the United States and Cuba, and Puerto Rico. Wines intended for South America are put in pipes containing 450 litres. Those for France are embarked from Barcelona or Tarragona to Marseilles, or transported over the Tarragona, Barcelona, and French railway. In these cases hogsheads of 605 litres capacity are used. The transport from the inland regions to the railway stations, or the nearest port, is effected over the main public highways. The cost of this transport varies according to the greater or less distance, and the state of the roads. The price by railway also varies according to distance, and weight, the cost being from 10d. to 4s. per hectolitre, from one end of the province to the other. Wine is almost the only important article of export from Catalonia, as, notwithstanding the importance of the grain cultivation, the production is by no means sufficient to cover the needs of home consumption.

General Notes.

Brussels International Exhibition. — A complete programme of the "Grand Concours International des Sciences et de l'Industrie," in connection with the Exhibition, to be held at Brussels in 1888 (see *ante* p. 159), has been prepared by M. Leon Somzée. It contains a series of questions proposed in connection with the different divisions of the Exhibition. The classification consists of fifty "Concours," commencing with professional and industrial instruction, and ending with the ornamentation of the galleries. A communication has been received from the Foreign-office, through the Science and Art Department, containing a copy of the circular letter addressed by the Prince de Chimaz to the Belgian Consuls, in which he asks for their assistance. The Comte Adrien d' Oultremont, member of the Belgian Chamber of Representatives, has been appointed Commissioner-General of the Government at the "Grand Concours." The *Moniteur Belge* of the 3rd inst., contains a royal decree nominating Vice-Presidents, Secretary-General, and Secretaries.

Baltic Canal.—A report, dated the 18th May last, has been received by the Board of Trade from Mr. C. S. Dundas, her Majesty's Consul-General at Hamburg, on the construction of the Baltic Canal, from which the following is extracted:—"It is intended to commence work on several divisions at once, as follows. The first division at Holtenau; the second, from Holtenau to Rendsburg; the third, from Rendsburg to a point further west; the fourth, from there to near the spot where the canal ends; the fifth, on the Elbe side. The total length of the canal will be 98 kilometres, with a breadth of 60 metres and 22 metres at the bottom, and a depth of $8\frac{1}{2}$ metres. There will be two locks, one at each end, the dimensions of which are not determined. For defence in time of war it will be protected on the Baltic side by the fortress of Friedrichsort, and on the side of the Elbe by a similar fortress, although of minor dimensions. The whole work, it is calculated, will be completed in eight years.

Patent-office Report.—The Report of the Comptroller of the Patent-office for the year 1886 has just been presented to Parliament. The numbers of applications for patents for the three years during which the last Patent Act has been in force are as follows:— 1884, 17,110; 1885, 16,101; 1886, 17,162; 14,822 of the 1886 applications were accompanied by provisional specifications, and 2,340 by complete. Of the applications for the year 1885, fifty-four per cent. were proceeded with, as compared with fifty-eight per cent. of those of 1884. Up to the present date no applications have been received for the grant of compulsory licenses, a provision rendering such applications possible, having, as will be remembered, been introduced for the first time into the Patent Act of 1883. Only three volumes of abridgments, and these all of them in continuation of former series, have been issued during the year. The report does not state what progress has been made with the new subject-matter indexes, which, according to statements made before the Departmental Committee of the Patent-office, were shortly to be issued. The total receipts of the office during the year amounted to £106,954, the payments amounting to £109,567, leaving a deficit of £2,613. This deficit, however, is really only an apparent one, because the whole cost of the purchase of certain new offices, amounting to £26,352, is charged to the present year. 23,717 designs and 324 sets of designs were registered during the year. The total number of applications for trade-marks was 10,677.

Journal of the Society of Arts.

No. 1,810. Vol. XXXV.

FRIDAY, JULY 29, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

HER MAJESTY'S JUBILEE.

The following is the list, complete to date, of subscriptions by members of the Society of Arts to the fund for the Imperial Institute :—

Amounts previously published........	2,289	10	6
William Bevan	5	5	0
Rear-Admiral Charles M. Buckle	1	1	0
Major-General Robert Cole..........	1	1	0
Rev. Charles Harris	1	1	0
William Pope......................	5	5	0
Joseph Sylvius Tamburini	3	0	0
Total	£2,308	3	6

This list is exclusive of contributions from members of the Society paid to the Institute direct, or through other agencies.

As the list is now about to be closed, it is suggested that any members of the Society who wish to contribute, and have not yet done so, should kindly send their names in at once.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows :—

1. The motors will be divided into two classes, *A* and *B*. Two gold and two silver medals will be allotted to each class.

(*A.*) Motors in which the working agent is also produced.

Steam.—Ordinary portable or semi-portable non-condensing engines.
Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer.
Hydro-carbon vapour.
Liquid hydro-carbon.

(*B.*) Motors to which the working agent must be produced.

Steam.—Detached engines, non-condensing, without boilers.
Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas.

Hydraulic.—Water motors.

Air.—Compressed-air motors.
Exhaustion motors.

2. Each class will be sub-divided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p. Each motor will be worked at or about the power at which it is entered.

[The horse-power herein mentioned is equivalent to 33,000 lbs. raised one foot high in one minute, as measured on the brake.]

3. For four-horse power and under, the entrance fee will be £10; above four-horse power, the entrance fee will be £2 10s. per h.p. The fees to be paid on entry.

4. No competition will be held unless ten motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The Council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the Regulations of the Royal Agricultural Society, viz. :—

a. All motors or producers subjected to more than a nominal pressure must be fitted with a pressure gauge. Before any motor can be worked, the pressure gauge must be verified by the judges.

b. There is no restriction as to the construction of motors, boilers, or producers, but the judges must be satisfied that the bursting strength of them is at least four times the working pressure, and that a hydraulic test of one and a half times the working pressure has been satisfactorily applied, if considered desirable.

c. Each exhibitor must declare the greatest pressure at which he proposes to work his motor.

d. No old boilers, that is boilers that have manifestly been at work for a considerable time, will be admitted without special thorough examination, and a certificate of safety from the judges.

e. Each boiler, of whatever form or size, must be provided with the following mountings :—

Two Safety Valves, each of sufficient size to let off all the steam the boiler can generate, without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set.

Two Sets of Gauges for ascertaining the water level.

One Steam Pressure Gauge, which must be tested and verified by the judges before the boiler can be used.

A Half-inch Cock, terminating in a half-inch male gas thread, for the purpose of receiving a testing pump.

One Check Feed Valve, immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water-level, or where there is a length of feed pipe between the engine and boiler.

f. The judges reserve to themselves the power of affixing any gauges that the peculiar nature of the machinery may call for, with the object of ensuring safety, and of obtaining information.

g. Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges require it.

h. Shafting, belts, gearing, high-speed machinery, and any other exhibits likely to prove dangerous, shall be securely fenced and protected to the satisfaction of the judges, but such approval shall not relieve the exhibitor from his own liability.

8. The points of merit considered of the greatest importance are—

a. Regularity of speed under varying loads.

b. Regularity of speed during the various parts of one revolution, or one cycle of revolutions.

c. Power of automatically varying speed to suit arc lights.

d. Noiselessness.

e. First cost.

f. Cost of running.

g. Cost of maintenance.

[In estimating the comparatively value to be allotted to each of these points of merit, the judges will give due consideration to the characteristics of each kind of motor, steam, gas, water, &c.]

9. The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal of the Society of Arts*. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the Society, all claims in respect of damage (if any) resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the arrangements or in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

13. All costs of fitting up and working the motors must be borne by the exhibitor. The Society will provide the brakes, indicators and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

Forms of entry can now be obtained on application to the Secretary.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen for objects coming under the following eight classes:—

1. Painted glass, £25, £15, £10.

2. Glass blowing in the Venetian style, £10, £5, £3.

3. Enamelled jewellers' work, £25, £15, £10.

4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.

5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.

6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.

7. Hand-tooled Bookbinding, £25, £15, £10.

8. Repoussé and chased work in any metal, £25, £15, £10.

The conditions under which these prizes are offered have appeared in previous numbers of the *Journal*.* They can also be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

BUILDING MATERIALS.

By W. Y. Dent, F.C.S., F.I.C.

Lecture I.—Delivered Monday, Feb. 14, 1887.

The term "Building Materials" embraces so wide and comprehensive a subject, that it may be well to make some explanatory remarks as to the nature of the information that is intended to be conveyed regarding the several matters to which I propose to direct your attention. As regards one of the most important of these, stone, it will be my endeavour to point out, as far as possible, the differences which exist in the composition of the principal descriptions used for constructive purposes; and the properties which stone should possess to enable it to resist the action of those influences which tend to bring about its disintegration and decay. Your attention will be directed to the nature of the proposals that have been made from time to time for the preservation of stone, and to the results that have been attained as regards the manufacture of what may be regarded as coming under the designation of artificial stone.

With respect to limes and cements, I hope to be able to afford some information as regards their respective constituents, the processes adopted in their preparation and manufacture, and the advance that has been made in the improvement of such processes during the last thirty years, and also to introduce to your notice some rather novel applications of the most important of all the different varieties of cements, generally known under the name of "Portland."

As regards wood, I shall confine myself to the question of its preservation from decay, and to a description of the various processes that have been adopted to increase its durability, and enable it to resist the attacks of the teredo and other boring worms.

Lastly, in connection with the subject of paints, I shall have a few remarks to make as to the nature and composition of some few of those that constitute the basis of that vast and ever-increasing number used for the preservation of wood and iron, which are continually being forced upon the attention of the public.

It is well known that although the differences which exist in the character and behaviour of various substances may for the most part be generally attributed to diversities in their composition, as determined by chemical analysis, yet in many cases these differences are due simply to changes in their molecular structure. It is necessary to remind you of this fact in connection with such a material as stone, because the value and quality of stone depends quite as much, or even more, upon its physical structure than upon its chemical composition. I may recall to your recollection a few familiar examples of important changes being effected in the behaviour and character of a substance, without such changes being accompanied by any alteration in the proportion of its chemical constituents. By subjecting starch to a temperature of 400° Fahr., it is converted into dextrin, or British gum (as it is sometimes called), a substance differing in its physical properties, but having precisely the same elementary constituents as the original starch, the proportions of carbon, hydrogen, and oxygen remaining unaltered; the change which takes place in the starch is caused by an alteration, produced by exposure to this temperature, in the molecular arrangement of its component particles. We have another example of a similar kind in phosphorus, which, under ordinary conditions, takes fire on exposure to air, and is readily soluble in carbon disulphide, but when exposed in an atmosphere of carbonic acid or other gas that exerts no chemical action upon it, to a temperature of 460° Fahr., it assumes what is called an allotropic modification, in which form, under the name of amorphous or red phosphorus, or Schrötter's phosphorus, it is no longer acted upon by the liquid in which it

* See *Journal* for April 29 and July 8.

previously dissolved, nor does it take fire when exposed to the air, and is thus converted into a material suitable for the manufacture of matches.

Zinc is a metal which exhibits very marked changes when exposed to the influence of variations of temperature. As ordinary spelter it is brittle; by exposure to a temperature of from 250° to 300° Fahr., it becomes malleable, and advantage is taken of this change to obtain the metal in a suitable condition for rolling into sheets; whilst if the temperature be raised to 410° Fahr. it becomes so brittle as to be capable of being powdered. The differences which exist in the quality of iron and steel are also, as is well known, not unfrequently due to the physical structure and not to the chemical constitution of the metal. With respect to stone, we have in chalk and marble the same chemical substance, carbonate of lime, but existing under different physical conditions.

Before, however, entering upon the question of the structure and composition of building stone, it may be well that we should fully understand the nature of the influences to which it is liable to be exposed, whether such influences are derived from the atmosphere under ordinary conditions, or from the more or less vitiated air of populous cities or manufacturing towns.

The subject of building stone is one that nearly thirty years ago excited a great deal of public attention, owing to the alarming reports that were then spread about as to the lamentable condition of the stone used in the then newly erected Houses of Parliament at Westminster. In a leading article of a scientific journal of that time, the following statement was made with reference to the condition of the building:—"In a century it will be—but we must not attempt to prophecy what it will be, for the probabilities are rather it will have ceased to be altogether." The excitement, however, gradually passed away as it became evident that the decay was confined to comparatively small portions of the structure, and that, at all events, the building was not likely to fall to pieces during the present century. The alarm, however, produced at least one good result, inasmuch as it led to an investigation into the nature of the stone, from which much useful information was derived upon a subject respecting which but little had been previously generally known. The records of the history of our globe afford evidence that the vast changes that have taken place at different periods, although frequently resulting from some sudden and violent convulsion, have been more generally due to the slow, gradual, but continuous action of natural forces over vast periods of time. In order to understand the cause of decay in stone, it is necessary that we should know something respecting the character and mode of action of the forces arising from atmospheric and climatic changes which exert their influence on everything around us, the immediate effects of which are apparently very feeble as compared with the magnitude of the results which they are ultimately capable of effecting.

These forces are partly of a mechanical and partly of a chemical nature. The former chiefly consist of those which result from the action of water which, with slow but certain progress, effects by its persistency changes so vast as to have no slight influence on the structure of the globe. That the hardest rocks will yield at length to the action of running water, their surfaces becoming rounded off by simple friction, is so well known as to have become proverbial. Besides the results produced by friction, water exerts a force of a most powerful disruptive tendency by the expansion which it undergoes in the act of solidifying or conversion into ice, of which fact some of us have probably been forcibly reminded during the winter season in a manner not conducive to our comfort by the bursting of our water-pipes, unless the necessary precautions had been taken to allow space for the increase in volume resulting from the freezing of the water.

The effects produced by frost in detaching large fragments, and sometimes very considerable masses, may be observed on any exposed surface of the softer rocks, and can scarcely fail to have attracted the attention of those who are in the habit of searching for fossils in the soft and friable cliffs of the Lias formation. It is, however, in mountainous districts that we can best appreciate the enormous disruptive force that is produced from apparently so simple a cause, and the important part which water plays in the breaking up of the older rocks, and in the formation of sedimentary deposits resulting from their disintegration. All rocks are more or less traversed by natural joints and minute crevices into which water finds its way, and these, by the repeated expansion of the water in its conversion into ice, are gradually enlarged into fissures, until finally the detachment of pieces from the mass is effected. The

weather-worn blocks which so frequently attract our attention, more especially in granite districts, from the curious and remarkable shapes which they assume, some of them being so evenly balanced as to form "logan" or logging stones, owe their peculiar appearance to the wearing away of those portions of the rock that are most easily acted upon by exposure to the influence of air and moisture. The effects produced by the action of the weather, combined with the mechanical force of the waves, are so great as to produce very considerable erosion of the English coast. Going back no farther than the year 1813, we find by the Ordnance map that there were then standing at Langley, near Beachy Head, four martello towers which at that time were all above high water mark; these have since all been destroyed by the advancing waves, the ruins of two of them being still visible at half tide.

Within a period of a few hundred years, the sites of former villages and farms have been covered by the sea, of which the old town of Cromer is an instance, and the rate at which the waves advance at several portions of the coast line has been estimated at two yards per annum. How little regard is generally paid to this coast erosion is shown by the fact that at a spot not far from Folkestone, upon which the sea is steadily encroaching, might have been seen, a short time ago, an advertisement board drawing the attention of the public to the excellency of the situation as a site for building purposes.

Water, as we are aware, possesses very great solvent powers, but possibly we should scarcely be prepared to learn that the solid matter annually carried off in solution is estimated to amount in some districts to as much as 140 tons from a square mile of surface.

The chemical changes effected by water are, to a great extent, due to the air which it holds in solution, and to the various accidental impurities it contains. The air in its normal condition consists of nearly 21 volumes of oxygen and rather more than 79 volumes of nitrogen, together with small but variable quantities of carbonic acid. From experiments made a short time ago by Dr. Russell, it appears the purest country air contains about three volumes of carbonic acid in 10,000 volumes of air, and that on a fine summer day in the city of London the proportion will not be increased beyond four volumes; but on a still, foggy day it is much greater, and may be increased to ten volumes, whilst, in some cases, as much as fourteen volumes have been found in a dense and long-continued fog. The impurities usually contained in a town atmosphere, such as sulphates and chlorides, are also largely increased in a foggy atmosphere.

The constituents of air are, however, dissolved in water as separate gases, and hence we find that the air contained in water differs materially in its composition from that of ordinary atmospheric air, the proportion of oxygen being increased from 21 volumes per cent. to nearly 34 per cent., whilst the proportion of carbonic acid is increased to a much greater extent. It is evident that such air must have enlarged powers of oxidation, and be much more capable of bringing about other chemical changes, of which we have an example in the extraordinary powers exhibited by river water in oxidising the organic matters with which it is polluted. The effects produced by moisture upon some descriptions of shale, such as alum shales containing large quantities of sulphur as sulphide of iron, affords a striking example of the action of water as a carrier of oxygen. When shales of this description are piled up in heaps, and moistened, combination of the sulphur with the oxygen conveyed by the water takes place, and the heat developed by the chemical action thus commenced is sufficient to produce, in many cases, disintegration throughout the mass.

The oxidising power of the air is also influenced by the small quantities of nitric acid and ozone generally present, which, although never very large in amount, are greater at periods of electrical disturbance. Ozone may be regarded as a condensed form of oxygen. It is oxygen in an allotropic condition, in which form it possesses greatly increased chemical activity, ozone surpassing ordinary oxygen in this respect just as oxygen does atmospheric air, possessing the power of bleaching substances, such as indigo or vulcanised rubber, that withstand the influence of ordinary oxygen. Ozone may be recognised by its peculiar odour, which is frequently observable in working an ordinary electrical machine, and its presence in the atmosphere is detected by means of test papers dipped in a solution of potassium iodide and starch. The iodide is decomposed by the ozone, and the liberated iodine coming into contact with the starch, strikes the well-known blue colour indicative of the presence of iodine. Ozone may be produced by means of a generator,

which is made on the principle of a Leyden jar, consisting of a long glass tube, coated with tinfoil on the inside, and surrounded by another tube similarly coated on the outside. Through the space between the two tubes, a current of dry air or oxygen is passed, which becomes converted into ozone on connecting the inner and outer tinfoil coatings with the terminals of an electrical induction coil. The condensation which oxygen undergoes by its conversion into ozone is considerable, three volumes of oxygen being condensed into two volumes of ozone. When ozone is exposed to a temperature of from 300° to 400° Fahr., it expands to its original bulk, and resumes the condition of ordinary oxygen.

Water penetrating as it does all rocks, to a greater or less extent in proportion to their porosity, is thus the means of bringing about great and very important changes which are included under the general term "weathering." The effects produced by rain in its passage through rocks are generally the results of oxidation, converting sulphides into sulphates, and ferrous into ferric salts or into peroxide of iron; the oxidation of salts of iron are the most striking on account of the change of colour which they undergo. Water, however, owing to the organic matter which it takes up in its passage through the ground, sometimes exerts a reducing action, and the results produced are reversed. Gypsum or calcium sulphate is thus converted by the reducing effect of the organic matter into calcium sulphide, which is readily decomposed into calcium carbonate and sulphuretted hydrogen, the latter, by oxidation, yielding sulphur, and thus giving rise to deposits of limestone and sulphur. This reducing action of water may also be observed in the white spots and veins which sometimes occur in red sandstones.

The observations of Professor Geikie on the effects produced by this weathering upon the gravestones in some of the older burying grounds of Edinburgh, are very interesting and instructive. Some of these tombstones are composed of limestone, others of granite and sandstone. In many of those composed of granite, traces of decay in some of the felspar crystals were detected, the polished surface having become gradually roughened, as the individual crystals had been more or less easily attacked. Some of the sandstones have proved to be remarkably durable, and seem in some instances likely to resist the ravages of time for a longer period than the granite. On a sandstone in Grey Friars churchyard, the chisel marks are still distinguishable, after the lapse of 200 years, the letters of the inscription upon it remaining sharp and distinct, the only observable change consisting of a roughening of the surface of the stone on the sides most exposed to wind and rain. Sandstones possessing distinct lines of stratification exhibited a tendency to split up along those lines under the influence of the weather, and in one instance of a flagstone set on edge, although the lettering of the inscription remained sharp, yet in the short space of forty years large portions of the stone had scaled off, affording a striking example of the necessity of attending to the well-known rule, that stones should be laid on their natural bedding. Many of the marble monuments had undergone considerable decay; irregular channels had been worn, partly dependent for the direction they had taken upon the trickling rain, and partly on the form of the monumental carving, or on differences in the structure of the marble. The surface of one marble obelisk had, in the short period of sixteen years, become so rough and granular, that it might readily have been mistaken for sandstone. The extent to which these alterations had taken place depended upon the position of the stone as regards exposure to rain and to the prevailing winds.

In one instance, the marble had been dissolved away to the depth of a quarter of an inch, the inscription having become quite illegible, although the stone had not been erected for more than eighty years. The inscription on the tombstone of Professor Black, in which his friends record the genius of the discoverer of latent heat and carbonic acid, has become partially illegible, and we may be sure that it never entered into their minds when expressing a wish to mark the resting place of the distinguished Professor "by the marble whilst it should last," how short a period would be sufficient to show to what an extent their confidence had been misplaced. The experiments conducted by Professor Pfaff, of Erlangen, led him to the conclusion that the annual loss of granite and syenite might be estimated at about ·008 millimetres in thickness, and that of limestone at ·013 millimetres, the limestone experimented upon being the hard Solenhofen limestone near Munich, used for lithographic purposes. Those rocks which contain iron not in the condition of peroxide afford marked examples of the effects produced by this so-called "weathering process" on account of the

changes in colour which they frequently undergo; thus, *e.g.*, the light coloured spathic iron ore from Alston moor in Cumberland, and from the Brendon hills in Somersetshire, is often more or less converted from a light-coloured carbonate of the protoxide of iron into a brown peroxide. Now any alteration of form by the oxidation of iron must obviously tend to disintegrate and break up the mass in which such alterations occur, and hence the presence of iron in a condition in which it is liable to oxidation is often a source of weakness. The presence of iron pyrites in slates (when not in the form of cubical crystals) is considered to be detrimental to their value. Iron pyrites is most familiar to us in the form of cubical crystals of a golden yellow, but it also occurs in rhombic prisms of a paler colour, as marcasite, and in radiated nodules which are more liable to decomposition, specimens of which in cabinet collections may often be observed to break up and fall to powder. The oxidation of metallic iron, or rusting, as it is generally termed, is not quite so simple a process as might at first sight appear to be the case. It is not simply the result of the direct combination of iron with oxygen. Iron will remain bright in dry oxygen for an indefinite period of time, whilst we are only too familiar with the fact that iron rusts very rapidly when exposed to air under ordinary circumstances. It is probable that we do not yet fully realise what a serious effect on the durability of many of the iron structures that have sprung up within the last forty years may be produced by this liability of iron to rust, because a number of years must elapse before such massive structures, as many of them are, become sufficiently weakened to render them dangerous; although it would seem from Mr. Clark's report, made in 1878 relative to the condition of the Britannia tubular bridge in reply to some alarming statements which had appeared as to the injuries it had sustained from the rusting of the iron, that where proper care is taken to preserve the iron, there need not be much ground for uneasiness, since the report states that during a period of twenty years the entire loss from the whole mass, about 10,500 tons, did not exceed 1 lb. in weight.

This rusting or combination of iron with oxygen results from the exposure of iron to the combined action of air, moisture, and carbonic acid. That moisture plays an important part in the oxidation of iron is proved by the fact that a piece of steel is rapidly corroded when exposed to the influence of a mixture of moist oxygen and carbonic acid, whilst but little, if any, effect is produced upon it by the dry gases. The influence exerted by the presence of carbonic acid is probably due to the tendency it would have to induce the formation of a carbonate of the protoxide of iron or ferrous carbonate, which is subsequently converted into a hydrated peroxide. It is well known that the tendency of two substances to combine with each other is increased by the presence of a third substance, which exhibits a powerful attraction for the compound resulting from their union. We have a familiar example of such action in the formation of saltpetre (potassium nitrate), which takes place under favourable circumstances in soils containing potash and nitrogenous organic matter, the union of the nitrogen with the oxygen of the air to form nitric acid being promoted by the presence of a powerful base, such as potash, for which the acid has a strong affinity.

The advantages derived from the use of lime in agriculture are to some extent due to a similar cause, the beneficial effects resulting from the application of lime being most evident when it is applied to newly broken-up ground or soils containing a large quantity of vegetable matter, the decomposition of which is promoted by the presence of lime inducing the formation of organic acids with which it combines. The well known protective influence which lime or any caustic alkali exerts in preserving iron from rust is to be attributed in a great measure to the absorption of carbonic acid. The coils of fine iron wire used in deep sea soundings (any rusting of which would be of serious consequence) must necessarily, for obvious reasons, be put away whilst they are wet, and therefore under the most favourable conditions for rusting, but they are preserved by being stored in a solution of caustic soda. Lime is also very commonly employed for preserving articles made of iron. It is well known that when iron has once began to rust its corrosion proceeds with increased rapidity. This may be due partly to the porosity of the oxide of iron formed, which causes it to absorb moist air more rapidly, but principally to the galvanic action arising from the porous oxide acting the part of an electro-negative element, and the metallic iron that of an electro-positive element, whilst the moisture absorbed performs the functions of the exciting liquid in the cell of a galvanic battery. Hence we see that

in order to preserve iron from being destroyed by rust, it is essential that every particle of rust should be removed as soon as it is formed, and that the smoother, brighter, and more polished the surface of the iron can be maintained, the better will it be able to bear exposure to oxidising influences.

Besides the serious effects produced by oxidation upon iron structures, which, of later years, have grown to such vast importance, the products resulting from the oxidation of iron possess a special interest in connection with the subject of stone, inasmuch as the oxides and other combinations of iron form the chief colouring matter of all rocks. In some cases, such as flints, which become white when calcined, the colouring matter is of a carbonaceous character; in other cases, the colour may be due to manganese, chromium, copper, as well as other metals, but the presence of these is rare, as compared with the oxides and other compounds of iron which are almost always present, giving rise to a variety of colours, including black, blue, grey, green, as well as every shade from light yellow to a deep red. The hard kidney-shaped nodules which are found in the red hæmatite ore of Cumberland consist of pure anhydrous peroxide of iron, whilst the brown ores, such as those of Northamptonshire, consist of the hydrated oxide, and in the well-known magnetic iron ore of Sweden, we have the black oxide.

Black oxide of iron is produced when steam is passed over iron at a red heat, the vapour of water being, under these conditions, decomposed, the oxygen combining with the iron to form the black or magnetic oxide, and the hydrogen being evolved as gas. This reaction has been utilised as a means of obtaining hydrogen gas on a considerable scale for filling balloons, and also for producing a coating upon iron which will protect it from further oxidation. This method of preserving iron from rust was made the subject of a patent some years ago by the late Professor Barff, and the process has been successfully carried out with respect to articles that are capable of being subjected to a high temperature without injury.

The iron to be preserved, which must be clean and free from rust, is placed in a chamber which is heated to a temperature of from 1,000° to 1,200° Fahr. Steam is generated in a boiler under a pressure of about 30 lbs. on the square inch, and superheated by passing through a series of wrought-iron pipes protected from the effects of the fire over which they are placed, by others of cast-iron. When the chamber is filled with the articles to be operated upon (which may consist of either wrought or cast-iron), the door is closed, and the temperature maintained chiefly by the steam admitted for a period of from three to five hours.

Another method of preserving iron from rust by means of a coating of this unalterable black oxide, has been patented by Mr. George Bower, which consists in passing the hot gases produced by the combustion of fuel over the iron, instead of steam, mixed with a proportion of air, which is increased or diminished according to whether an oxidising or reducing effect is desired to be produced. If the iron be rusty, a reducing flame converts the red oxide into the black or magnetic oxide. In the case of wrought iron that is not rusty, Mr. Bower prefers to produce in the first instance a little red oxide by increasing the quantity of air, as he finds that the black oxide finally produced is rendered thereby less liable to scale off.

Barff's process is best adapted for polished steel or wrought iron; Bower's for cast iron and rusty iron. The two processes are now combined, and frequently articles are subjected first to the heated gases produced by combustion, and finished by superheated steam.

There can be no question as to the success of the process as regards the smaller descriptions of iron goods, for when properly conducted, iron will bear exposure to the atmosphere under the most trying conditions without a particle of rust being produced, and if specks of rust should make their appearance on spots that may not have been thoroughly coated with the black oxide, the rust shows no tendency to spread. This process is specially adapted for intricate castings, as the gas penetrates the finest lines, producing a thoroughly protective coating. As a means of preparing articles for gilding, it has been of great assistance in overcoming the difficulty previously experienced in coating iron so as to prevent it from rusting, and as a necessary consequence throwing off the gilding. The unavoidable expense incurred in heating large masses of metal to the required temperature renders it difficult to apply a process of this kind to heavy castings, neither is it suitable for protecting wire, because the coating being of a brittle character, breaks off when the wire is bent, unless the coating is too thin to afford efficient protection to the wire

There is a difficulty in applying it successfully to nuts and screws on account of the oxide filling up the threads to such an extent as to prevent their working satisfactorily, neither can it be considered a suitable process for chains, the links of which, by friction against each other, soon rub off the coating of black oxide. The necessity of raising the iron to a red heat is also a bar to the use of this process in many cases in which otherwise it would be invaluable as a preventative of rust. The process ordinarily adopted for preserving iron from rust, termed "galvanising," consists in immersing the iron in a bath of melted zinc, and thus covering the iron with a coating of zinc which rapidly oxidises on the surface, but under ordinary circumstances the oxide formed remains firmly attached to the metal, and thus protects it from further corrosion. It has lately been proposed to deposit the zinc electrically upon the iron, a process which is said to be successfully carried out at a less cost than the ordinary galvanising process.

The effects produced by carbonic acid are most strikingly exhibited in its solvent powers as regards the carbonate of lime, carbonate of magnesia, and protoxide of iron. Many natural waters contain ferrous carbonate in solution, more expecially those known as chalybeate waters, and from such water, when exposed to the air, peroxide of iron is deposited by the oxidation of the ferrous carbonate. The hard waters obtained from the chalk contain lime held in solution by carbonic acid, and the softening of such water by what is known as Clark's process, consists in adding just sufficient lime to neutralise the carbonic acid that holds the carbonate of lime in solution, when the whole of the lime existing as carbonate is precipitated, the water being softened down to about one-third of its original hardness, an immense advantage in water required for domestic purposes. It is the solvent action of carbonic acid upon carbonate of lime that gives rise to those magnificent incrustations that occur in the caverns of limestone rocks, such as are found at Clapham Cave in the north of Yorkshire, Castleton in Derbyshire, and the Kitcraft Quarry in the Isle of Portland. These incrustations frequently take the form of icicles hanging from the roof, when they are known as stalactites, which are sometimes several feet in length. The pillar-like masses rising from the floor are termed stalagmites. These incrustations are produced by the rain water, which, charged with carbonic acid, percolates the limestone beds, and dissolves in its progress the carbonate of lime. When the water saturated with carbonate of lime reaches the roof of a cavern and becomes exposed to the air, it loses some of its carbonic acid, and a particle of carbonate of lime is deposited, and when the drop reaches the floor, a further deposit of carbonate of lime takes place, owing to the escape of carbonic acid until, after the lapse of time, large masses of these deposits are accumulated. A very remarkable example of the formation of incrustations of this description during a comparatively short period of time, was discovered when widening the north bridge at Edinburgh connecting the old town with the new. Between the arches of the bridge and the roadway were a number of chambers or vaults varying in height, and from 8 ft. to 10 ft. in breadth, which had not been opened since the building of the bridge 100 years before. From the vaulted ceilings of these chambers (especially from the joints of the masonry), hung hundreds of delicate sparry crystals of snowy whiteness; many of these reached the floor, forming slender, thread-like pillars resembling a grove of brittle canes, some of these pillars being as much as 6 feet in length. A large number of little stalagmitic mounds, each surmounted by a short, slender stalk, were also observed, which were evidently the lower ends of what once had been continuous pillars. The bridge was built of sandstone, and this curious formation had been produced by water, which had trickled through the masonry, and had thus become saturated with carbonate of lime from the mortar in the joints.

The solubility of carbonate of lime in water charged with carbonic acid not only gives rise to these very remarkable and curious incrustations, but exerts a very considerable influence upon geological limestone formations, the insoluble carbonate of lime being deposited as a sedimentary rock. The white concretionary limestone, known as travertin, of which both ancient and modern Rome are largely built, is an example of such a deposit which is taking place in some parts of Tuscany at the rate of six inches a year. Carbonate of lime being deposited from its solution in carbonic acid, serves to bind together other materials with which it comes in contact in the course of such deposition; it thus serves as the binding material of several varieties of building stone, and becomes an important agent in the formation of rocks. An excellent

example of such formation is to be seen at Bermuda. The islands are surrounded by immense beds of calcareous sand, to the extent of twenty miles, resulting from the disintegration and breaking up of the coral reefs which abound in that part of the world. This sand is washed up by the sea, caught by the prevailing winds, and blown up into hills 40 ft. or 50 ft. in height; the rain falling upon these calcareous deposits dissolves out from the upper portions carbonate of lime, which is again deposited as the water percolates the drift, and binds together the particles of sand, as well as other *débris* into a coherent mass which gradually hardens into a rock.

Under normal conditions of the atmosphere, the agents which tend to alter and decompose whatever is subjected to their influence, are few in number and comparatively slow in their action, deriving the enormous power they exert from the persistency of such action through long periods of time; but this can hardly be said to be the case as regards the atmosphere of our large towns, and especially of those in which extensive manufacturing operations of various kinds are carried on. The air of such towns becomes charged with substances of a much more deleterious and corrosive character than those which I have described as belonging to the atmosphere in its normal condition. In the neighbourhood of alkali works, potteries, and other manufactories where large quantities of common salt are decomposed, the air is liable to contain appreciable quantities of hydrochloric acid, although the amount of this highly corrosive mineral acid that is now allowed to escape into the air is very much less than was formerly the case before the Alkali Act was passed, which enforces the condensation of all acid fumes as far as practicable. The sulphuric acid, either in a free or combined state, existing in the air of towns, is of more serious consequence than the hydrochloric, not only on account of its existing in much larger quantities, but because it is derived, in a great measure, from the sulphur contained in the coal burnt for domestic as well as other ordinary purposes, so that no extension of the Alkali Act could relieve us from this impurity. The total consumption of coal in all large towns is enormous, and when we consider that the greater part of this coal contains from a half to two per cent. of sulphur, we must see what a vast quantity of sulphuric acid is likely to be produced from this source. Taking the average quantity of sulphur in coal as amounting to one per cent., we have one ton, or 2,240 lbs., yielding 22 lbs. of sulphur, which, by absorption of oxygen, is capable of producing 67 lbs. of oil of vitriol. The late Dr. Angus Smith, who for several years carried out a long series of investigations on the impurities existing in the air of large towns, found the air in some parts of Manchester to contain as much as from 800 to 1,200 grains of sulphuric acid (either in a free or combined state) in every 1,000,000 cubic feet, and from 100 to 150 grains of hydrochloric acid either as such, or as chlorides. The presence of this large amount of acid matter existing in the air was corroborated by the quantity found in rain water; the mean result of a vast number of experiments, conducted through a whole year, gave an average of from three to four grains of these acids, either in a free or combined state, in an imperial gallon. In parts of London where coal is consumed chiefly for domestic purposes, 730 grains of sulphuric acid, either as such or in combination, was found in 1,000,000 cubic feet of air. To whatever extent these acids may be neutralised by combination with the ammonia, or other alkaline matter with which they come in contact, there can be no question but that the sulphuric acid (either in a free or combined state) existing in the air of towns is very detrimental to many descriptions of stone, and altogether precludes the use of such a material as Caen stone for the exterior of buildings which are so situated as to be liable to be exposed to its influence. On examining the crumbling surface of Caen stone from buildings in large towns, it has been found that the decayed portions of this stone contain a considerable quantity of sulphate of lime. Dr. Angus Smith found mortar in Manchester in which the lime had been to a large extent converted into sulphate, and on examining the black deposit which collects in the hollow spaces between the stones on the walls of St. Paul's Cathedral, I found it to consist of particles of sand and other *débris* (which no doubt had greatly assisted in producing abrasion of the surface of the stone), soot, together with a very large quantity of sulphate of lime. When this crust remains firmly attached to the stone the policy of removing it may be questionable, as it probably serves to protect the surface of the stone from further action.

The amount of acidity acquired by rain in large manufacturing towns is sufficient to

cause it to act rapidly upon galvanised iron roofs unless protected by paint. The zinc oxide which under ordinary circumstances remains attached to the metal is readily attacked by weak acids, and if subjected to the action of acid rain, the zinc coating is rapidly destroyed, and the surface of the iron is exposed.

It has been proposed to use iron covered with lead for corrugated roofs, which are subjected to the influence of a smoky atmosphere as being less easily attacked than the zinc. In galvanising, the iron simply requires to be immersed in a bath of melted zinc, but lead will not attach itself to iron under similar stated circumstances. This difficulty is stated, however, to be overcome by mixing with the lead a small quantity of phosphorus and arsenic. This method of coating iron was made the subject of a patent in America and in this country three years ago. Having considered the nature of the influences to which stone is liable to be exposed which tend to promote its destruction, let us now turn our attention to the chemical composition and physical structure of the various descriptions of stone used for building purposes, and their relative capability of resisting exposure to such influences as have been described. Of these a block of hard and compact well-polished granite is unquestionably one of the most durable. To be hewn out of the solid rock has in every age been regarded as typical of endurance, and the word granite is so associated in our minds with all that is lasting and permanent, that to speak of any building as being constructed of granite is considered to be a guarantee of its strength and durability. The term granite is understood by geologists to indicate a rock consisting of quartz, felspar, and mica in a crystalline granular condition, which may be associated to a greater or less extent with other minerals, such as hornblende, talc, schorl, &c., which give rise to a number of rocks differing in their composition and character, and distinguished from each other by various names, derived either from that of the prevailing constituent or from the localities in which they were first known. Thus we have talcose granite, in which the quartz, felspar, and mica are associated with talc; hornblende, or syenite-granite, in which the mica is more or less replaced by hornblende. The word syenite, derived from Syene in Egypt, whence was first obtained the beautiful material so largely used by the Egyptians for obelisks, and other architectural purposes, has been hitherto understood to represent a granite in which the mica has been replaced by hornblende, but this term is now restricted by geologists to a rock consisting of a crystalline granular mixture of orthoclase and hornblende.

Of the three constituents of typical granite, quartz offers the greatest resistance to any weathering action. When it exists in the form of hard colourless crystals (commonly known as rock crystal) it is pure silica. The crystals, however, frequently assume various shades of colour, according to which they have received appropriate names, such as rose quartz, milk quartz, the amber-coloured crystals being known as cairngorm stones, from having been found in the Cairngorm Mountains of Aberdeenshire. Silica in this highly crystalline condition resists the action of almost every chemical reagent with the exception of hydrofluoric acid, but it can be made to combine with an alkali by the assistance of heat. Felspar, as represented by the mineral orthoclase, consists of silica, alumina, and potash, and of silica, alumina, and soda, as represented by the lighter coloured mineral albite. Lime also enters into the composition of some felspars, such as oligoclase, which contains 2 per cent. of lime, and labradorite, which contains from 10 to 12 per cent., this last being an opalescent felspar, exhibiting a peculiar iridescent display of colours when the light falls upon it in certain directions.

Mica, so named from its being easily divided into glistening scales, consists of silica and alumina, associated with magnesia, soda, and lime, in varying proportions; thus we have potash mica, consisting of silica, alumina and potash; and magnesia mica, in which the alumina is partially replaced by magnesia, passing (as the proportion of magnesia increases) into soft talc, which is chiefly composed of silica and magnesia.

The term granite, as commonly employed, is used in a much more comprehensive sense than belongs to it legitimately, as understood by geologists, for under this general term are included many hard crystalline rocks which differ in their composition from true granite; the so-called granites of Leicestershire, Guernsey and Jersey, as well as that of the Malvern Hills, partaking more or less of the character of syenite.

The several descriptions of granite differ materially from each other, both as regards their composition and physical structure; whilst those which are well crystallised are

extremely durable, there are some granite deposits which possess but little cohesion, and readily yield to the influence of atmospheric changes. In several districts examples of granite of this latter description are to be found, but there are none so remarkable as those which exist in Cornwall, where some of these granitic deposits are in such a friable condition that a slight blow is sufficient to make the mass fall to pieces, forming the deposit known by the name of china stone, whilst in other parts, the decomposition of the felspar of the granite has proceeded to such an extent that the deposits have become converted into china clay or kaolin, so named from two Chinese words signifying a high ridge. The natural china clay contains crystals of quartz, and flakes of mica, with sometimes a little schorl and undecomposed felspar; it is covered by a layer of sand, stones, and impure discoloured clay, varying from 30 to 40 feet in thickness, which it is necessary to remove before the clay can be worked. The broken up clay is exposed to the action of a stream of water, which, carrying off the finer portions in suspension, is led through long channels (in which the sand and rougher particles are deposited) into large pits from 30 to 40 feet in diameter, and from 7 to 10 feet in depth, in which a further deposit of the heavier particles takes place; it is finally conducted into tanks in which the fine clay held in suspension by the water is allowed to deposit, the effluent water being sometimes collected in reservoirs to be used over again. The clay, which is of the consistency of soft mud, is removed from the tanks to the drying floors, which are formed of fire-clay tiles heated by flues. It is spread upon these floors to a thickness of from six to nine inches, and when dry constitutes the kaolin or china clay of commerce, as supplied for the manufacture of porcelain and other purposes. This china clay is prepared on an extensive scale, the larger works turning out as much as from 3,000 to 8,000 tons per annum. The first china or "hard" porcelain (by which is meant a porcelain capable of bearing a high temperature without fusion) made in Europe was that manufactured at Plymouth by Mr. Cookworthy, who discovered this clay at St. Stephen's, in Cornwall, in 1755. The clay is largely used as a dressing for calico, by paper makers, to give body and weight to their goods, and in the manufacture of ultramarine blue. Extensive deposits of this clay exist in China, America, in the north of France, and in the island of Bornholm, which supplies the clay required by Sweden, Denmark, and the north of Germany.

The constituent of granite that is generally the first to undergo decomposition is the felspar, although there are cases in which the felspar stands out in sharp well-defined crystals, exhibiting quite as little tendency to decay as the other portions of the rock. In decomposing, the crystals lose their lustre, and as the disintegration proceeds, the potash and soda are washed away as soluble salts (for the most part as carbonates), leaving a hydrated silicate of alumina constituting the kaolin that remains. Experiments have been made which show that under favourable circumstances carbonic acid exerts an appreciable amount of action upon a variety of minerals, such as hornblende, serpentine, or apatite, and that this action is augmented by increased pressure.

With respect to the origin of the enormous deposits of crumbling granite, such as those found in Devonshire and Cornwall (covering as they do a large area of ground, and having in some places a depth of more than 100 feet), no very satisfactory explanation can be given. The clay in some cases rests upon granite of the hardest description, and it is the opinion of the best authorities that these deposits have either never been properly consolidated, or that they are the results of surface decomposition which have been swept by the action of water into the spots which they now occupy.

In selecting stone for building purposes, too much attention cannot be paid to its physical structure, inasmuch as whatever may be its composition, stone which is of a hard, dense, crystalline character is not only capable of resisting more effectually the action of erosive agents when in actual contact with them, but is not exposed to the same amount of contact as is the case with stone of a more porous character, for when rain falls upon a close, polished surface it cannot sink into the stone, and consequently any matter of a corrosive nature with which it may be charged does not remain in contact with the stone for any length of time, but is carried off before it has had an opportunity of exercising an injurious effect. It is obvious that the more crystalline and compact is the character of the stone, the more capable it is likely to be of resisting the effects ordinarily produced by exposure to atmospheric influences, whether such may be of a normal description, or whether they may be of a more powerfully corrosive nature. It is to its physical structure alone that marble

(which consists of carbonate of lime) owes its durability; its highly crystalline character rendering it sometimes capable of being favourably compared with granite, as is the case in some of the churches of Devonshire erected from 400 to 500 years ago, in which the marble shows fewer signs of alteration than the granite.

The importance of crystalline structure, as affecting the durability of stone, appears to have been recognised from a very remote period. Whoever the constructors of the great pyramid may have been, and whatever purpose they had in view in carrying on a work involving such an enormous amount of labour, it is quite certain that they must have been proficients in the art of building in stone. They appear to have exhibited much skill in its selection, and were acquainted with the best methods of dealing with large blocks, fully appreciating the advantages to be derived from fitting such blocks as closely together as possible with very thin joints. The celebrated red porphyry of Egypt, which derived its name from its purple colour, was hard enough to be capable of taking a fine polish, and was largely used by the Egyptians, and subsequently by the Romans, for statuary purposes. It was upon a circular slab of this material, now at St. Peter's at Rome, that the Roman emperors were crowned. Columns of porphyry, after the lapse of 1,900 years, still exist which retain their freshness of colour. The term porphyry is now applied to any rock having distinct crystals embedded in a felspathic matrix, and is used to designate the crystalline character of a rock. We have thus quartz porphyry, porphyritic granite, porphyritic greenstone. Cornwall is especially rich in these porphyritic rocks, a very excellent material, capable of taking a high polish, being obtained from the neighbourhood of Bodmin. It was a schorlaceous variety of this description which is found on the surface in immense boulders near Luxullian, and hence known as luxullianite, that was selected for the sarcophagus of the late Duke of Wellington in St. Paul's Cathedral. The very perfect condition in which works of art of such great antiquity as those of Egypt have been found, is no doubt mainly due to the dryness of the climate of Egypt, but still, in part, to the excellent quality of the material employed. The syenite granite of Egypt was extensively worked as far back as 1,300 years B.C., the quarries whence it was obtained occupying an extensive tract of land between the first cataract of the Nile and the town of Assouan, which now stands near the site of the ancient Syene.

The famous Egyptian obelisks, one of which, known as Cleopatra's Needle, originally erected at Heliopolis (the "On" mentioned in the book of Genesis) about 1,800 B.C., and now standing on the Thames-embankment, were obtained from these quarries. The obelisk at Rome was also one of those that stood in front of the Temple of the Sun, where it is said to have remained for 2,000 years before it was removed to Rome by Cæsar Augustus after the battle of Actium.

It is somewhat remarkable that the neighbourhood of this ancient Syene, which for thousands of years had been the frontier town dividing Egypt from Nubia, should now in this nineteenth century be the site of explorations which are creating so much interest. On examining the sandstone hill on the west bank of the Nile, the removal of the sand led to the discovery, in 1885-6, of a series of tombs where the nobles and chiefs of ancient Syene had been buried, containing inscriptions which indicate that the hill had been used as a cemetery as far back as 3000 B.C. From these inscriptions much interesting information is to be gathered of the manners and customs prevailing at the remote period to which they allude, some of them being of great historical interest. The freshness of the paintings on some of the shrines is surprising, and the colours are wonderfully true to nature. The hieroglyphs for granite hills are good representation of granite, and that of an elephant is painted in a greyish sepia the exact colour of the animal.

Of the granites used in this country for building purposes, the most important are those obtained from Devonshire and Cornwall, and the Scotch granites. The Scotch granites are too well known to require any lengthened description. We find examples of the grey granite of Aberdeenshire in nearly every cemetery, and columns of the celebrated red granite of Peterhead adorn the public buildings of almost every town of importance.

The Cornish and Devonshire granites are of a more porphyritic character than the Scotch granites, the crystals being of a larger size. As regards their relative durability, they are both of them, when properly selected, of so permanent a character as to allow of the selection of either the one or the other for any engineering work being made upon other considerations than their relative liability to

decay. The Devon and Cornish granites possess one advantage, inasmuch as blocks of a much larger size can be obtained of these granites than from the Scotch quarries. Granite obtained near the surface, and near the edges of the formation, is not unfrequently defective owing to imperfect crystallisation, and the use of such granite is considered to have been the cause of the unsatisfactory condition of some of the Cornish granite used in the erection of Waterloo-bridge, which has sometimes been referred to as a proof of the inferiority of the Cornish granite to the Aberdeen granite, although Cornish granite from the same district has been found to be perfectly satisfactory when used for the Thames-embankment and elsewhere.

The Shap Fell granite of Cumberland is porphyritic in its character, and is easily recognised by the large crystals of red felspar which are too conspicuous to escape being noticed. There are two varieties of this granite, the dark and the light coloured. The dark variety has of late years been largely employed in many parts of London, and of this we have a good example in the posts at the western entrance of St. Paul's Cathedral.

The so-called Leicestershire granites form a remarkable and very interesting series of crystalline rocks which are quarried within a radius of about twelve miles from the town of Leicester, known as the Charnwood Forest range. Of these, the Mountsorrel is a syenite or hornblendic granite, of which there are two varieties, a grey and a red, the grey blocks being sometimes coloured red at their edges, from which it would appear that the colouring matter (consisting mainly of iron oxide) has been absorbed through the joints of the rock. Blocks are obtained of a sufficiently large size for building purposes, but it is more extensively used for paving setts and road metal. The rock is traversed by a basaltic dyke, running right through the hill, known locally as "blue stone," which is used for road metal only. The Groby and Markfield quarries are very much alike as regards the material they yield, but it is of a still more syenitic character than that obtained from Mountsorrel, and would formerly have come under the designation of syenite; it is largely used for kerbs, paving setts, and road metal. The Stoney Stanton quarries yield a material similar to that obtained from Groby and Markfield in its composition, but differing in structure, which is used for the same purposes. That obtained from the Barden Hill and Charnwood Sheepshed quarries partakes more of the character of greenstone. The Barden Hill has somewhat of a slaty cleavage, and as it will not break into cubes, can only be used for road metal. The granite yielded by the Sheepshed quarries possesses the highest specific gravity of the series; it can be made into paving setts, and is also used for road metal. The excellence of the Leicestershire granites, as well as those of Guernsey, for the purpose of making paving setts, or for road metal, does not depend so much upon their specific gravity or hardness, or upon the amount of resistance they offer to a crushing force, as upon their peculiar toughness, which is probably derived from the manner in which the crystals composing them are interlocked with each other.

In the paving of the quadrangle of the India and Colonial offices, both the red and the grey varieties of Mountsorrel granite have been employed. Granite is imported from Norway, which finds a ready demand for kerb stones, for which it is particularly adapted on account of the length of the blocks in which it is supplied.

Some of the indurated sandstones that have been converted by pressure and infiltration of silica into quartzite, form an excellent material for road metal, of which we have an example in that quarried at Pontesbury, near Shrewsbury

Amongst granitic or metamorphic rocks may be classed that very beautiful material for decorative purposes, known as serpentine. Varieties of this rock are found in various parts of the world, in the mountains of the Alps and the Vosges, at Portsoy in Scotland, where it is known as Portsoy marble, and in West Galway, where it is termed Connemara marble. The term marble is restricted by geologists to limestones which are capable of taking a fine polish, but the term is still employed (in what very probably was its original meaning, since the name is derived from the Greek word μάρμαρος, signifying gleaming or sparkling) to designate any kind of stone, irrespective of its composition, that is capable of being polished. In no part of the world is serpentine seen to greater advantage than in Cornwall, where it forms a large portion of the promontory of the Lizard; much of the beauty of the celebrated Kynance Cove being due to the variegated colours of the serpentine rocks by which it is surrounded. The value of serpentine depends upon the variety and beauty of the colours it displays,

and on the fact that, although it is capable of being easily polished, it is a comparatively soft rock, and can be readily cut or turned in a lathe. It is a hydrated silicate of magnesia, and is liable to deterioration by exposure to the weather in this climate; it is, consequently, employed chiefly for interior decorative work.

Miscellaneous.

THE TECHNICAL INSTRUCTION BILL.

The Government's Technical Instruction Bill was published on Saturday. The "local authority" that is to put the measure in motion is the School Board, or in a borough where there is no School Board, the council. In districts which are outside boroughs, and have no School Boards, no provision whatever appears to be made for establishing technical schools. The first step is for this local authority to pass a resolution that it is expedient to provide for supplementing by technical instruction the elementary education supplied in its district, and for that purpose to put in force the provisions of the Bill. The protection of the ratepayers consists in the provision that thereupon any fifty persons entitled to vote at the election of members of the local authority, or one-third of the total number of those persons, may require a poll to be taken as to the carrying the resolution into effect. This poll will be by ballot, and, as far as possible, like that of a contested municipal election; the voters being those entitled to vote at the election of the School Board or the town council, as the case may be, and each person having one vote only. If the resolution be negatived at the poll, it may not be again proposed until after the expiration of a year. For London a special scheme is proposed by Sir W. Hart Dyke, but it is not yet inserted in the Bill. If a resolution is not negatived, the powers of the local authority are to be these:—(1) To provide technical schools for its district; or (2) to combine with any other local authority for the purpose of providing technical schools common to the districts of both authorities; or (3) to contribute towards the maintenance, or to the provision and maintenance, of any technical school; or (4) to make such arrangements as may seem expedient to it for supplementing by technical instruction the instruction given in any public elementary school in its district. As to what is to be included in "technical instruction," that is practically left to the decision of the Science and Art Department. In the Bill it is defined as instruction in the branches of science and art with respect to which grants are for the time being made by that department, or in any other subject which may for the time being be sanctioned by the department; and a "technical school" includes not only a school, but also a department of a school, which is giving technical instruction to the satisfaction of the Department of Science and Art. The conditions under which schools are to be conducted are those specified in the minutes of the Science and Art Department in force for the time being, and required to be fulfilled in order to obtain a grant from the department; but a minute which is not now in force is not to be deemed to be so for the purposes of the Bill until it has lain a month on the table of both Houses of Parliament. Thus the working out of the scheme is left almost wholly to the Department of Science and Art.

When once a local authority has started a technical school it cannot discontinue the school at its own discretion. In order to do so it must satisfy the Science and Art Department that the school is unnecessary. It is required to keep its school efficient, and for this purpose it is to have the same powers as a School Board now has for providing sufficient school accommodation for its district. But as the administration of the Bill is intrusted to the Science and Art Department, that department is in these matters substituted for the Education Department. With the sanction of the former department two or more local authorities may enter into any agreement which may be necessary for carrying into effect a resolution under the Bill. And the agreement may provide for the appointment of a joint body of managers, for the proportion of the contributions to be paid by the respective authorities, and for any other matters which in the opinion of the department are necessary for carrying it out. And where there is an ordinary technical school in the district, the managers are authorised to make an arrangement with the local authority for transferring their school to it, the provisions of section 23 of the Elementary Education Act of 1870 being made to apply.

The expenses to be incurred by a local authority in these matters are to be defrayed out of the "local rate," that is, the school fund where there is a School Board, and where there is none the borough fund or borough rate. But no payment is to be made out of the rate in respect of a scholar until he has passed the sixth standard, or an examination equivalent to it.

POPULAR BEVERAGES.

By P. L. Simmonds.

In all countries, civilised and savage, men exert their ingenuity to concoct some popular beverage either as a thirst quencher or an intoxicant. The indigenous vegetable products suitable for the purpose are made available, whether they be grains, fruits, roots, or the sap of trees. Some of these beverages are moderately pleasant, others inebriating; but, as

the temperance advocates have found after numerous experiments, it is extremely difficult to obtain any palatable refreshing drink without a small portion of alcohol forming part of its constituents. A brief glance at some of the less known national drinks may not be without some interest. The indigenous manufacture and consumption depends much on the supply of the raw material from which it is locally produced, although in rich and civilised countries extraneous supplies of popular beverages are imported, where they cannot be made locally in sufficient quantity.

In some localities cider is popular and cheap; the per-centage of alcohol in cider ranges from $5\frac{1}{2}$ to 9.

The production of cider varies in France considerably year by year, and sometimes it falls as low as 4,000,000 or 5,000,000 hectolitres, while in other years it reaches 17,000,000 or 18,000,000. It is principally consumed locally in the country districts, and very little is exported.

The best cider is said to be made in the Province of Normandy, where it was introduced many ages since by the Moors, but cider is made in no fewer than 54 departments. About 150,000 barrels of cider and perry are annually made in the western counties of England, the sweet in Hereford and the rough in Devon, and a good deal is also made in North America. In the Dominion of Canada about 1,000,000 gallons of cider are drank yearly. In Chili, after making cider and wine from their apples, they extract from the refuse a white and finely-flavoured spirit, and by another process they procure a sweet treacle, or, as they term it, honey. When properly fermented and prepared, the black mulberry yields a pleasant vinous liquor. In the cider counties of England mulberries are sometimes mixed with apples to form a beverage known as mulberry cider.

The fishermen of Newfoundland, Labrador, and the Gulf of St. Lawrence, drink large quantities of spruce beer; it is considered an admirable corrective of their diet, which consists principally of fat pork and salt fish. The process of making it is simple. A few black spruce branches are chopped into small pieces and put into a pot containing six or eight gallons of water, and boiled for several hours. The liquor is then strained and put into a cask that will contain eighteen gallons. Molasses is added in the proportion of one gallon to eighteen gallons; a pint of the grounds of the last brewing and a few hops, if at hand, are also put in, and the cask filled up with cold water, is left to ferment; in twenty-four hours it becomes fit for use. Spirits are frequently mixed with spruce beer to make the drink called "callibogus." In New Zealand a drink somewhat resembling spruce is made from the twigs of *Dacrydium taxifolium*, and was used by Captain Cook.

From the sap of the birch tree some of the tribes of Northern Russia prepare their ordinary drink, "birkenwasser," from which they also make vinegar; nd in some districts they boil it into a sweet syrup, which serves them instead of sugar. For those who are too poor to drink beer or mead, this northern wine is the only potive drink.

A drink delightfully acid and refreshing is made in Brazil from the pulp of the capsule which envelopes the seed of *Cacao theobroma.*

The saccharine liquor extracted from the unexpanded flowers of the Ita palm of British Guiana is said to afford a liquor resembling champagne in its briskness.

The sap of the Sontar palm (*Borassus flabelliformis*) is obtained from the stems of the bunches of fruit when cut. This liquor is drank either fresh or after it has undergone a light fermentation. It bears also the name of towak or palm wine. Sometimes a species of *Strychnos* is infused with it, which produces a stupefying and intoxicant beverage sold daily in the bazaars in the Moluccas, especially at Amboyna, in sections of bamboo. Palm wines are common in most warm climates. In the Eastern Archipelago it is obtained from the gomuti palm (*Arenga saccharifera.*) The principal production of this palm is toddy (from the Sanscrit táde), which is obtained in the following manner:—One of the spadices is, on the first appearance of the fruit, beaten on three successive days with a small stick, with the view of determining the sap to the wounded part. The spadix is then cut a little way from its root (base), and the liquor which pours out is received in pots of earthenware and sections of bamboo or other vessels. When newly drawn the liquor is clear, and in taste resembles fresh must. In a very short time it becomes turbid, whitish, and somewhat acid, and quickly runs into the vinous fermentation, acquiring an intoxicating quality. In this state great quantities are consumed.

In Ceylon, Madras, and other parts of India toddy is obtained from the sap of the palmyra palm (*Borassus flabelliformis*), and there are two kinds, the unfermented juice called sweet toddy, and the fermented or "culloo." The sap of *Caryota urens* is also drunk. The sap of the wine palm (*Raphia vinifera*), called "bourdon" and "lope," is much relished by the savage tribes of West Africa. Other of their favourite inebriants are "wawa," or plantain wine, and "bombe," small beer made of grain. The latter is served in neatly carved and coloured gourds, and the contents are imbibed like sherry cobbler, through a reed. The cool, refreshing milk of the cocoanut is highly esteemed, and other palms are brought into requisition for beverages, such as *Phoenix dactylifera*, and *Sylvestris*, *Attalea cohune*, *Elais guineensis*, and *Jubea spectabilis.*

In Siam, China, and Japan, rice is the principal grain used for distilling, and forms the "lan" of Siam, the "shonchou" and "mandarin" wine of China, the "saki" of Japan, and the "badek" and "brom" of Java.

In China the rice wine they use is by no means agreeable; it is always taken hot, and somewhat resembles Madeira in colour and taste.

The Malays have a fermented liquor made from rice which they call "gelang."

The Javanese beverage "brom" is prepared from the fermentation of rice, and is a kind of beer, and not the produce of distillation. The fine arrack (a name derived from "arak," Arabic for ardent spirit) is an invention and manufacture of the Chinese, of which the materials are boiled rice, molasses, and palm wine.

Saké, or rice beer, is the principal and almost the only alcoholic beverage of Japan. The production is estimated at about 150,000,000 gallons annually, equal to about 4½ gallons per head. Until the last two or three centuries saké was not manufactured on a large scale, but each household made its own supply. Now there are very large breweries in different parts of the country. There are a great many varieties of saké to be obtained in commerce, differing somewhat in taste, flavour, and price, and distinguished by fancy names. The proportion of alcohol in saké varies from 5 to 15 per cent. The "saké" of Japan is very heating and heavy, and appears to be as vinous in quality and strength as European ale or beer. It is flavoured with honey or sugar.

The Indians of Chili make a drink of maize. The grain is first baked, then steeped in water for a certain time, after which it is boiled and set by to settle, and when fined is fit to drink.

Indian corn is largely used for distillation all over North America, and in South America it appears to have been made into "chica," or maize beer at a very remote period; for it was a common drink of the Indians long before the Spanish conquest. The liquor is said to be of a dark yellow colour, with an agreeable slightly bitter taste. It is in universal demand on the west coast of South America, and is consumed in vast quantities by the mountain Indians; scarcely a single hut in the interior is without a jar of this favourite liquor. From the stalks of the maize a beverage is also obtained in Mexico.

In some of the River Plate States the inhabitants make a liquor from the sweet pods of the Algarrobo (*Prosopis alba*) which, when new, is refreshing, but becomes alcoholised after fermentation. In some districts this liquor is the principal attraction at social meetings.

Sir Joseph Hooker tells us how Murwa beer is made in the Himalayas Millet seed is moistened and fermented for two days. Sufficient for a day's allowance is then put into a vessel of wicker-work, lined with india-rubber to make it water-tight, and boiling water is poured on it with a ladle of gourd from a huge iron cauldron that stands all day over the fire. The fluid, when quite fresh, tastes like negus of Cape sherry, rather sour.

In some parts of the East, a fiery intoxicating beverage is made of jaggery (sugar), bhang (hemp), poppy seeds, pepper, cardamoms, and nutmeg.

The fermented fruit of the peach gives an excellent brandy, which is chiefly manufactured in the United States. In the southern parts of Hungary the well-known liquor, "shivowitza," is made from the shiva plum.

The liqueur called "maraschino," which is chiefly manufactured in the Italian States, and Dalmatia, is prepared from a variety of cherry. The fruit and seed are crushed together, one part of honey to the hundred added, and the whole mass subjected to fermentation; during this process it is distilled. The kernel of the cherry contains the elements of hydrocyanic acid, and is accordingly much used for communicating its peculiar flavour to brandy and liqueurs.

From the succulent peduncle of the cashew-nut (*Anacardium occidentale*) an excellent spirit has been distilled with diuretic properties, similar to the best Hollands. A wine made from it resembles in taste an ordinary claret sweetened with sugar, and is a popular beverage among the poorer people in South America. It is the custom of the Brazilians to suck a cashew before breakfast, but at any hour of the day the juice is delightful. It is sweet and delicious, slightly astringent, and a wonderful allayer of thirst. The juice of one cashew is more grateful to a thirsty person than a goblet of the purest water.

The Australian aborigines obtain a fermented liquor by soaking the seed vessels of the *Pandanus*, and washing out the sweet, mealy substance contained in the lower part between the fibres.

The national drink of the Mexicans is "pulque," the sap of the maguey or American agave. After expressing the juice between rollers, or, as was formerly done, by means of suction, it is carried to vats (which are made of raw hides) for fermentation. The sap, which resembles cider, and has a very disagreeable smell, taken alone or diluted with water, is a common sweet beverage in use in Mexico. When fermented this liquor is very intoxicating, containing about 36 per cent. of absolute alcohol. To strangers both the taste and smell are horrible, something of the style of rotten eggs, but people seem to get accustomed to the flavour. Bayard Taylor says:—"I can only liken the taste of this beverage to a distillation of sour milk (if there can be such a thing), strongly tinctured with cayenne and hartshorn."

Correspondence.

AGRICULTURAL PESTS OF INDIA.

In 1880, I was permitted to examine the scientific records of the India-office, and in concluding my report (14th June, 1880), I suggested that it would be for the good of India to obtain reports on agri-

culture, cattle diseases, grains and their diseases' and on the noxious creatures and plants hurtful to mankind.

Subsequently, in the *Journal* of the 13th November, 1885, you printed a letter from me to the India-office, of date the 8th August of that year, also the India-office reply, mentioning that the correspondence had been forwarded to the Government of of India. My letter had briefly recommended that there should be half-yearly reports "on the insects which injure the agricultural, horticultural, and forest produce of India, suggesting means of preventing, and remedies for same." That recommendation has been duly acted on. Reports on the attacks of the *Paraponyx oryzalis*, the *Leptocorisa Bengalensis*, the *Alope ocillifera*, and the *Achæa melicerte*, have appeared, and are of great economic and scientific value, but there has not been mention made in any report of any vegetable pest, nor of any murrain.

On the 11th May last I submitted to H.M. Secretary of State for India a small volume on the "Agricultural Pests" of that country, with a letter recommending that, in addition to losses from insect ravages, the reports might include notices of the injuries sustained from epizootic maladies, from reptiles, and the larger mammals.

The Secretary of State for India acknowledged my communication on the 7th inst., and informed me that a copy of my letter, with the volume to which it relates, had been forwarded for the information of the Government of India.

Much information has been printed on all these topics, but it has appeared in newspapers, in journals, or in official documents, and it has seemed to me desirable to provide a more accessible form of record. I think that a fair beginning has been made of a much-needed work, which, let us hope, may be progressive. Assistance may confidently be looked for from the learned of Europe, who will not grudge giving a portion of their time to so important an investigation, and many in India will take part in the inquiry.

EDWARD BALFOUR.

General Notes.

THE URAL COPPER MINING INDUSTRY.—The *Revista Tecnologico Industrial* records the fact that out of 1,758 copper mines in the Ufa government only 28 are in operation. Charcoal was used in the treatment of the ore, and the gradual destruction of the forests in the district has led to a scarcity of fuel, which has tended to a considerable extent to bring about this decline of a once flourishing industry. When the metal was at a high price, some Ural marks of copper (specially the Parhkoff mark) were much esteemed. The quantity raised now is so small that working hardly pays; the expense of transport to be treated preventing the metal from competing in the market. It is, therefore, said to be in contemplation to cease working altogether.

GERMAN FACTORY LEGISLATION.—Amongst the reforms proposed by a select commission, appointed by the German Reichstag to investigate the question of factory labour, are the following:—(1) From April 1st, 1890, no children to be employed in factories who have not completed their 13th year, and have satisfied the requirements of their local educational laws; (2) women not to resume factory work till four weeks after their confinement; (3) women not to be employed in quarries, mines, and wharves, or in carrying burdens in connection with building operations; (4) women not to be employed on Sundays and holidays, nor between the hours of 8.30 p.m. and 5.30 a.m., and the occupation of women and children to cease at 6 p.m. on Saturdays and on the eves of holidays; (5) women who have households to look after, not to be employed in factories longer than ten hours daily; (6) measures to be adopted for male and female operatives being separated as far as practicable in establishments where both sexes are employed.

DRILL COMPETITION.—The annual drill competition of lads attending public elementary Schools in the metropolis was held on the 22nd July, at Lambeth Palace fields. At this competition the voluntary schools competed as well as Board schools. Lieut.-General D. Anderson, the Commandant of the Royal Military College, Sandhurst, had been chosen as the judge, and among those present, the Society of Arts was represented by Mr. Edwin Chadwick, and the London School Board by the Rev. Joseph R. Diggle (the chairman), and other members of the Board. The lads marched on to the ground by schools, and, while none wore a distinctive uniform, some of the masters had provided special caps and collars for their scholars, and the appearance of most of the lads was neat and smart. General Anderson took the companies out separately, and watched their drill closely, and very great interest was manifested in the result, which decided the winners of the Society of Arts banner. In the result General Anderson said the banner must remain where it was, and that the Gideon-road Board School had won it. He commended, however, the lads of the Lyndhurst-grove, Camberwell, Board School, and of the St. Gabriel's, Pimlico, Voluntary School. The boys having cheered General Anderson, the whole body marched to Trafalgar-square, where they were dismissed.

Journal of the Society of Arts.

No. 1,811. Vol. XXXV.

FRIDAY, AUGUST 5, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1888.

The Programme for 1888 is now ready, The Examinations will be held on the 9th, 10th, 11th, and 12th of April. The Practical Examination in Vocal and Instrumental Music will be held in the Society's House during the week commencing on Monday, May 21st. A copy of the Programme is sent to each institution with this week's *Journal.*

Copies can also be obtained gratis on application to the Secretary.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in last week's *Journal.*

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

BUILDING MATERIALS.

By W. Y. Dent, F.C.S., F.I.C.

Lecture II.—Delivered February 21st, 1887.

The materials that come under the designation of stone as used for building purposes, consist either of the rocks belonging to the earlier geological formations (such as the various descriptions of granite), or of deposits that are the result of the decomposition of such formations, as represented by those that are of a sedimentary character. These sedimentary rocks may be classed under two heads, sandstones and limestones, some of them partaking of the nature of both, such as the Mansfield redstone, which is a siliceous magnesian limestone.

Of the sandstones there are a great variety, some of them being of too hard and too coarse a texture to be available for buildings the character of which necessarily entails a considerable amount of ornamental work, but they afford excellent material for plain heavy masonry, where strength and durability are the main points to be considered. We have examples of such material in the grey sandstones of Dundee and Arbroath, which have been much used for paving in Edinburgh and Glasgow, and of the coarser varieties in that which is known as Bramley Fall stone, used for Kirkstall Abbey, built in the 12th century, the name being derived from the quarry in the neighbourhood of Leeds, whence this description of stone was first obtained. This quarry has been closed for some time, but the original name is retained, and now represents a quartzose sandstone, varying considerably in its texture, belonging to the millstone grit formation, and obtainable in very large blocks from a number of quarries in Yorkshire, Lancashire, and Derbyshire. It is chiefly used for engineering works, such as engine beds, dock walls, and foundations, being especially adapted for massive work of every description where large blocks are required.

The finer descriptions of sandstone come under the designation of "Freestone," a term that has no very distinctive meaning, but one which is commonly employed when speaking of any stone, whether it be a sandstone or a

limestone, that is capable of being easily tooled, quite irrespective of its chemical composition. There is an ample supply of excellent sandstone for general building purposes both in England and Scotland. In England this is especially the case as regards the counties of Lancashire, Yorkshire, and Derbyshire, in which there are a number of quarries yielding a very durable material, which is, at the same time, sufficiently soft to admit of being easily worked with a chisel.

The stone from the Darley Dale and Knabb quarries, in Derbyshire, has been largely used in Manchester, and it would not be easy to find a better test of the durability of stone than subjecting it to the influence of such an atmosphere as that of the city of Manchester. The New Stanton and Coxbench quarries yield an excellent material for building purposes, some of the stone from New Stanton being also suitable for grindstones.

Of the Yorkshire sandstones, amongst those that have been longest known may be mentioned the Hare Hills and Park Spring stone, which have been extensively employed for many years in London and in various parts of the country.

The Scotgate Ash quarries, near Pately Bridge, yield an excellent building stone, some of the beds affording a material suitable for landings. A fine grained sandstone is obtained near Sheffield, which has few rivals as regards its properties as a grindstone, and in the district which lies between Bradford and Halifax are obtained in large quantities the flagstones for which Yorkshire possesses such a high reputation. The red Corsehill stone from Annan, in Dumfries, is one of finest of our red building stones. It is uniform in its texture, of a rich deep red colour, which is but little liable to alteration. This stone is peculiarly adapted for use in conjunction with bricks or terra-cotta, and has been employed with good effect for several buildings in London and its neighbourhood.

One of the finest sandstones is that known as the Craigleith stone, which has been very extensively used in Edinburgh. It is a close-grained compact stone, consisting almost entirely of silica, the particles of quartz sand being bound together by a siliceous cement, the total quantity of silica it contains, as shown by analysis, amounting to 98 per cent. The permanent character of this stone has been thoroughly established; exposure to the weather for 200 years having in some cases scarcely produced any effect upon it, but it is questionable, however, whether the stone now obtainable under this name possesses the excellent properties of the original supplies. The Minera stone from near Wrexham, in Denbighshire, has been largely used in Liverpool and Manchester, and was employed in London for the building near the Mansion-house occupied by the National Safe Deposit Company.

At Grinshill, near Shrewsbury, there are quarries which yield a fine grained building stone, of which there are three varieties, white, yellow, and red, which has been extensively used in Liverpool, Manchester, and Birmingham, and towns in the midland counties, as well as in London. This stone was employed for many of the churches in Shropshire, including Battle Church, standing on Shrewsbury battle-field, and has proved to be a good weather stone.

The Prudham stone, from the neighbourhood of Newcastle, has within the last two or three years been introduced into London, and from the condition of this stone, which was employed for buildings in Woolwich Dockyard some forty years ago, it may (if obtained from the same beds) be expected to prove a durable stone.

Uniformity of texture is an important consideration, more especially as regards sandstones, inasmuch as some of this class contain portions differing in character from the mass of the stone, showing a tendency to weather at a different rate. Sometimes such portions are less liable to alter than the mass, and are thus left as excrescences, whilst in other cases they weather more rapidly, and the stone presents a more or less pitted appearance.

Limestones, as a class, are quite equal in importance to the sandstones as regards the number and variety of the beds yielding an excellent material for building purposes. They differ widely from each other as regards their chemical composition, from white marble, which is pure carbonate of lime, to the magnesian limestone, in some descriptions of which the proportion of carbonate of magnesia is nearly equal to that of the carbonate of lime. Marble is generally regarded as the result of carbonate of lime having been subjected to intense heat in a confined space, where there was no opportunity for the escape of the carbonic acid, and consequently under great pressure. It is a highly crystallised carbonate of lime of a density equal to that of granite, weighing about 170 lbs. per cubic foot.

Although we have not in England the beautiful white statuary marble of Italy, nor such deposits as would be required for a cathedral like that of Milan, yet we have in Derbyshire and Devonshire, marbles that leave little to be desired as a material for ornamental and decorative work.

The beautiful black marble from Ashford, in Derbyshire, has been worked for forty years, the beds varying in thickness from three to nine inches. It has been extensively used for ornamental work in church buildings and public edifices, of which we have an example in the bases and caps of the balustrading round the ladies' gallery of St. George's-hall, Liverpool. The other varieties of marble from these quarries, as well as those from Hopton-wood, in Derbyshire, have been largely employed for ecclesiastical as well as other decorative work throughout the country. The Devonshire marble can be procured in very large blocks, and to such an extent is this the case that a polished marble tank, weighing when finished nine tons, cut out of a single block, has been supplied from the Oreston quarries near Plymouth. The marble columns at the Home and Colonial Offices were also obtained from these quarries.

There are several other limestones that are of such a highly crystalline character as almost to entitle them to be classed with marbles, of which the Niddersdale limestone may be taken as an example. By far the larger portion of the limestone ordinarily used for general building purposes is derived from the beds of the oolitic system, so named from the particles of some varieties of these beds being more or less of a granular character, bearing a resemblance to the roe of a fish. This appearance is not of a marked character in many of the stones belonging to the oolitic series, but in some of the beds of Bath stone, and more particularly in the Ketton stone, it is too evident to escape the notice of the most casual observer. It is supposed that this appearance is due to the stone having been formed from the disintegrated particles of former limestones which have become rounded by attrition and deposited in a granular condition, or the carbonate of lime has been deposited upon some particle of sand or fragment of shell which was kept in motion by flowing water saturated with carbonate of lime. Such a production of oolitic grains may be observed in process of formation in the springs of Carlsbad. The most important of the building stones belonging to the oolitic system is undoubtedly that which is known as Portland stone, which may be regarded as the type of a good limestone for ordinary building purposes. It has been used more extensively than any other description for the public buildings of London. St. Paul's Cathedral, Somerset-house, the National Gallery, the Custom-house, the Post-Office, the Royal Exchange, and the new Law Courts, have all been built of this material, and experience has proved that (when carefully selected) it is one of the best adapted for resisting exposure to the baleful influence of a town atmosphere. Fortunately for its reputation, great care has generally been exercised in preventing any inferior stone being employed. Sir Christopher Wren had the stone for St. Paul's Cathedral quarried and exposed to the air for three years before it was brought to London, a full opportunity being thus afforded for rejecting any blocks that exhibited signs of inferiority; the stone used for the Royal Exchange also underwent a special inspection at the quarries.

There are numerous quarries in the island of Portland, and a series of beds, only a few of which yield a really good material. Taking the Waycraft quarry as an example, we find that after sinking to a depth of 25 feet through several strata of but little value, and known by various local names, the Roach bed, 2 ft. 6 in. in thickness, is reached. The stone of this bed is shelly and full of cavities, and consequently cannot be used for building purposes where a good facing stone is required; it is, however, hard and durable, and is employed for underground work, its money value not being more than about one half that of the best Portland stone. Below this is the finest bed of the whole series, known as the Whit bed, 9 ft. 6 in. in thickness; and after sinking eight feet deeper, through stone of little value, termed "curf," the lowest of the series, or base-bed, is reached, a name that has sometimes been converted into "best bed," which is somewhat misleading, inasmuch as, although sometimes preferred by masons, it differs slightly in its character from the Whit bed, and is considered inferior to it in durability. It also sometimes contains irregular bands of flint. The thickness of the several beds varies considerably in different quarries. This stone contains 95 per cent. of carbonate of lime, the hard crystalline particles of which it is composed, as well as the material that binds them together, consisting of carbonate of lime.

The next stone in importance belonging to the oolitic system, is that obtained from several quarries in the neighbourhood of Bath, with which everyone is more or less familiar under the name of Bath stone. The several beds vary as regards the character of the stone they yield, perhaps to a greater extent than is the case with any other description, and unless great care is taken in its selection, it will generally be found to prove a failure if exposed to such an atmosphere as that of London. At the same time examples are not wanting of its exhibiting as much durability as other descriptions of limestone, and in one instance, where it has been used along with Portland stone in the same building, in which special care was taken in its selection, it exhibits fewer indications of decay than the Portland. The vast trade that is now carried on in Bath stone may be said almost to have commenced with the opening of the Great Western railway, although the stone has for a long time been a favourite with builders, having been employed since the 12th century.

The stone imported from Caen, in Normandy, was introduced into this country shortly after the Norman conquest, and was extensively used in building churches down to the middle of the 15th century. Its fine, soft, even texture, renders it peculiarly suitable for ornamental work, and there is no better stone for internal decorations involving elaborate carvings. It is not, however, a good stone as regards its capability of resisting the effects of exposure to atmospheric influences, and is quite unsuitable for the exterior of buildings erected in large towns. With but few exceptions, when exposed to a town atmosphere, it has proved a complete failure, its defective condition having had, in some instances, to be concealed by paint.

The Doulting stone, obtained from the beds of the lower oolite formation at the base of the Mendip hills, in Somersetshire, resembles Portland as regards its composition, and also with respect to its density and porosity; and although it more resembles Bath stone in appearance, it is superior to it in quality. This stone was used for building Glastonbury Abbey, in the 12th century, and for Wells Cathedral.

Amongst other stones belonging to the same class may be mentioned the Ancaster stone, from near Grantham in Lincolnshire, which has been largely used in that and the neighbouring counties, and to some extent in London. The stone from Casterton in Rutlandshire was used for the cathedrals of Norwich and Ely, and in building some of the colleges at Cambridge. The Clipsham stone, from the same county, was employed in the restoration of the cathedrals of Ely and Peterborough, and is similar to what was formerly known as the Barnack stone, which acquired considerable reputation as a good weather stone. The Ketton stone, from near Stamford, has already been alluded to as possessing a very marked granular appearance, exhibiting its oolitic character to an unusual extent. It is a very excellent stone (of which we have a good example in the Church of St. Dunstan's, Fleet-street), and is somewhat peculiar in that it possesses but little if any distinctive line of bedding.

The Headington stone, from the neighbourhood of Oxford, has been largely employed for many of the colleges and churches in that city, the condition of which does not afford any favourable evidence of the durability of the Oxford oolites, much of the stone of the colleges and other buildings in Oxford exhibiting signs of exfoliation and decay. One of the better class of the Oxford oolites is the Charlbury stone, used for the Central Barracks, Oxford. A stone has been largely employed in Oxford for several years past which is obtained from Milton, near Chipping Norton; it has acquired a favourable reputation with several well-known architects, and seems likely to prove more durable than most of the stone that has been generally used for the colleges at Oxford.

The stone which is known by three different names, Tisbury, Chilmark, and Wardour, is obtained from quarries in the neighbourhood of Salisbury, the original Tisbury quarry being now closed. It differs in its composition from the limestones before mentioned, inasmuch as it contains ten per cent. of silica, which partly exists in minute particles forming nuclei, round which carbonate of lime has been deposited, and partly as a crystalline matrix, forming the binding material of the stone. Salisbury Cathedral was built of this stone, and it is now being used for the repairs of Westminster Abbey. The Kentish rag is a dense, hard, and very durable limestone belonging to the greensand formation, largely employed in the south of England for forts and harbours. It is obtained from quarries in the neighbourhood of Maidstone, where it occurs in layers from six inches to two feet in thickness, with alternating bands of a soft siliceous limestone, locally termed hassock

it is employed for many of the picturesque country churches in Kent, the hassock being used for the interior portion of the walls.

Of the siliceous limestones, the finest example is that known as the Mansfield stone, of which there are two varieties, the white and the red, both of which contain nearly 50 per cent. of silica, associated with variable quantities of carbonate of lime and carbonate of magnesia. This stone, more particularly the red variety, has deservedly obtained a high reputation for the beauty and uniformity of its colour, and the fineness of its texture.

The magnesian limestone, or dolomite, as it is sometimes called, has obtained a not very enviable notoriety from its having been selected for the Houses of Parliament at Westminster. The name dolomite belongs properly to a mineral of a peculiar granular and crystalline structure known as bitter-spar, which consists of fifty-four parts of carbonate of lime and forty-six parts of carbonate of magnesia, the name being derived from that of a French geologist who discovered it in the Alps. The magnesian limestones are very variable in their character, both as regards their chemical composition and their physical structure. The stone used for building purposes is chiefly obtained, in this country, from the counties of Nottinghamshire and Yorkshire, in the district which lies between Mansfield and Chesterfield, stretching in a northern direction as far as Tadcaster. The quarries in the neighbourhood of Tadcaster were known to the Romans, who employed this description of stone in the construction of the multangular tower, the ruins of which, in the Museum-gardens at York, are still an object of interest. York Cathedral, erected in the 13th century, Ripon Minster, as well as many of the churches in York, are built of this stone, in many of which the signs of exfoliation and decay are but too evident.

The selection of magnesian limestone for the Houses of Parliament was decided upon chiefly on account of the very excellent state of preservation in which this stone was found at the cathedral church of Southwell, in Nottinghamshire, Roche Abbey, near Tickhill, and the castles of Conisborough and Bolsover. The particular stone chosen was that from the quarries at Bolsover, in Derbyshire, whence the stone used for the church at Southwell had been obtained. The stone that could be supplied from these quarries was, however, found to be too small in quantity for so extensive a building, and blocks of sufficient size were not procurable; other sources of supply had consequently to be found, and the North Anston quarries, on the borders of Yorkshire, were determined upon.

The choice of magnesian limestone, notwithstanding all that has occurred, in connection with the defective condition of many portions of the building at Westminster, cannot be regarded as altogether an erroneous one. Magnesian limestone had long been regarded as affording an excellent material for building purposes. It was, in the opinion of Sir Christopher Wren, only inferior to Portland, and examples are not wanting which afford evidence of its capability of bearing exposure to such an atmosphere as that of London without injury, of which the Museum of Practical Geology, in Jermyn-street, may be quoted as an instance. The greatest care was taken in selecting the kind of stone to be used; a Royal Commission was appointed, consisting of men eminent for their geological attainments as well as for their practical experience, who undertook a laborious investigation, visiting all the principal quarries in England, and examining 150 varieties of stone. The cause of the unsatisfactory condition of much of the stone employed in the building is unquestionably due to want of inspection at the quarries, and—as a necessary consequence of this laxity of superintendence—the inefficient manner in which the stone was worked. We find stones taken from the same part of the building, varying materially as regards their porosity and physical character, to such an extent as could not possibly have occurred had proper precautions been taken for preventing the arrival in London of any stone of inferior quality. The securing a proper supervision over all quarrying operations is of quite as much importance, as care in the selection of the description of stone most suitable for any building operations, of the truth of which the Palace at Westminster affords, unfortunately, plenty of evidence.

A very excellent stone of this class is obtained from Huddlestone, situated between Sherburn and Tadcaster, consisting of 54 per cent. of carbonate of lime, and 41 per cent. of carbonate of magnesia, of which we have an example in London in the cross erected in front of the Charing-cross-hotel.

Building stone of good quality is obtained from various parts of the magnesian limestone district, differing in composition as regards the relative proportions of lime and magnesia.

The nearer the composition of the stone resembles that of true dolomite, and the more crystalline is its character, the better building stone is it likely to prove. The Bolsover stone, originally selected for the Palace at Westminster, contained 51 per cent. of carbonate of lime, and 40 per cent. of carbonate of magnesia.

It would be useless to attempt to give anything like a detailed account of the vast number of very excellent building stones with which this country abounds, but I shall endeavour to make a selection of such as may best serve to illustrate the chief differences that exist between them, both as regards their chemical composition and physical structure. In examining a specimen of stone, our first inquiry would naturally be directed towards ascertaining its chemical composition, so far, at all events, as would be requisite for deciding upon the class to which it belongs, whether it is a sandstone or a limestone, or partakes of the character of both. Having determined this point, we should ascertain the condition in which its constituents exist, whether crystalline or otherwise, and proceed to a careful examination of its physical properties generally, such as its hardness, density, and strength, and also its porosity, as shown by the amount of water it will absorb. It is upon these physical properties that the value of a stone mainly depends, for we find sandstones containing very nearly the same amounts of silica, or limestones containing the same proportions of carbonate of lime, and yet differing widely from each other in their relative value for building purposes, their durability or otherwise being mainly dependent upon their physical structure.

In conducting an investigation of this nature, the examination of sections of stone under a microscope will afford much useful and valuable information as to the nature and character of the minerals of which it is composed. As regards the more practical tests, it is very desirable, if not absolutely essential, that they should be conducted in as uniform a manner as possible, otherwise the results obtained are no longer capable of being compared with each other, and consequently lose much of their value.

The capability of stone to resist a crushing force is usually stated in the circulars issued by quarry owners, as being represented by the number of pounds per square inch, or tons per square foot, which it is capable of bearing without breaking; but these results are not strictly comparable with each other unless the tests have been conducted in the same manner, and with blocks of the same size. The method most generally adopted, is to subject 6-inch cubes, bedded between pieces of pine three-eighths of an inch in thickness, to hydraulic pressure, noting the amount of force obtained when the first crack makes its appearance, and also when the crushing takes place. Another useful test of the strength of stone is to expose repeatedly, small slabs saturated with water, and enclosed in a metal case, to a freezing temperature.

The density may be taken approximately by simply weighing 6-inch or 12-inch cubes, if carefully cut; but for more accurate determinations, the usual manner of taking the specific gravity of solids by ascertaining the difference in weight in air and when immersed in water, may be resorted to. For this purpose, small 1-inch or $1\frac{1}{2}$-inch cubes are the most convenient sizes. The specimens, previously dried and weighed, should be rendered impervious to water by immersion for an instant in melted paraffin, or by coating them with a thick solution of shellac in methylated spirit, and again weighed. The difference between the specific gravity of paraffin or shellac, and that of water, is not sufficient to give rise to any serious amount of error, whilst the necessary correction for this difference can be easily calculated for, if greater accuracy be desired.

In drying specimens of stone, care should be taken to avoid too high a temperature; if time allows, it is preferable to do so by simply exposing them to the air of a warm room, and under no circumstances should the temperature be allowed to exceed 212° Fahr. When dried rapidly at this temperature, the specimens should be allowed to remain for an hour after removal from the drying chamber, in order that they may cool down and take up their hygroscopic moisture before weighing. The variations that exist as regards density in different kinds of stone are considerable. The lighter descriptions, such as Caen and Bath stone, weigh from about 116lbs. to 123lbs. per cubic foot, whilst the heaviest, such as granites and marbles, will weigh from 165lbs. to 175lbs.

The amount of water absorbed by stone is sometimes determined by exposing the dry specimen to an atmosphere saturated with moisture for forty-eight hours, a method which gives very good results when making a careful comparative examination of two different specimens of stone; but a more rapid

and sufficiently accurate method for most practical purposes is to immerse a slab about three inches square and half-an-inch in thickness in water, until no further bubbles of air make their appearance, when it is taken out; the water on the surface is removed with a piece of bibulous paper, and the increase in weight ascertained. The less durable kinds of stone, such as Caen stone and many descriptions of Bath stone, absorb as a rule more water than Portland, Ancaster, or Doulting, whilst granite and marble may be regarded as non-absorbent. In a report to a Commission appointed at Munich on the subject of stone, the following tests were proposed for adoption :—

1st. Determination of the salts soluble in water.

2nd. Determination of its porosity by ascertaining the amount of water taken up by capillary absorption during twenty-four hours, as well as that absorbed by total immersion.

3rd. Exposure of a sample saturated with water and enclosed in a metal case, to a temperature of from 5° to 14° Fahr., such exposure to be repeated ten times.

In carrying out experiments with stone, it is always desirable to have a specimen of stone of known quality and belonging to the same class as those under examination, included in the investigation, since it is difficult to ensure the conditions under which experiments are made being precisely the same under all circumstances.

However much care may be taken in the examination of specimens, it must never be forgotten that it is absolutely necessary, before deciding on the relative merits of different kinds of stone as to their suitability or otherwise for any special purpose, that the quarries should be visited, and the several beds carefully inspected, for in almost every quarry, whatever the description of stone may be, a very material difference will be found to exist in the quality of the stone yielded by its several beds.

Samples of stone from the same quarry, and sometimes even from the same bed, in which no practical difference can be detected by chemical analysis, will not unfrequently be found to exhibit considerable variations in physical structure, a knowledge of which can only be obtained by actual inspection of the stone *in situ*. No opportunity should be lost of obtaining information as to the condition of buildings in which the stone has been employed, and all quarrying operations should be conducted under efficient superintendence, in order that no stone of inferior quality should be permitted to leave the quarry.

Time should be allowed for what is termed the "quarry water" to dry out, by which the surface of the stone is hardened, and the tendency of pieces to split off, so frequently exhibited by newly-quarried stone, especially in frosty weather, is decreased. The hardening which takes place during the process of slow drying, by exposure to the air, is probably owing to the deposition within the pores of stone of mineral matter previously held in solution by the quarry water. This beneficial result is not obtained when any process of artificial drying is adopted, which is too rapid to allow the matter deposited to assume such a crystalline structure as results from the slow drying effected by simply exposing it to air. Moreover, such artificial drying may have an injurious effect, on account of its giving rise to unequal expansion and contraction of the surface of the stone as compared with the moist interior.

Preservation of Stone.

The question of the preservation of stone is one upon which much time and trouble have been expended without, however, leading to the attainment of any very satisfactory results, inasmuch as when good stone is employed no preserving process is required, and if, unfortunately, the best has to be made of inferior stone, it is only in exceptional cases that the cost and trouble involved in the adoption of any such process is likely to be incurred upon an extensive scale.

When the extent of the decay which had taken place in the stone of the Houses of Parliament was first fully realised, it created a good deal of excitement, and a Government Commission was appointed to inquire into the subject, who invited proposals for arresting its progress. In answer to this invitation, a great number of projects were brought forward for the attainment of the desired object, differing widely from each other in their character, many of them being the outcome of much thought and careful study of the question, whilst others were of a very crude nature and had no pretensions to any merit.

The principle upon which any process of this kind depends for success is evident, for since it is by means of water that the acid matters which act so injuriously upon stone obtain access to it, any process which succeeds in filling up the pores with some material of a

permanent and unalterable character must be likely to act as an effective preservative. This, at first sight, would seem very easy to accomplish. There is no difficulty in closing the pores of a piece of soft chalk or Caen stone, so as to harden the surface and make it non-absorbent of water. When, however, stone is once in position, and we have it in the form of a vertical wall, the task is a more difficult one. Under such circumstances it is impossible to make any solution penetrate to a sufficient depth by a single application; it requires to be frequently repeated, beginning with very weak solutions, before the stone can be made to absorb it in sufficient quantity, or to any considerable depth; whilst if it be a mere surface covering, it is likely to be of little more use than ordinary painting, which requires to be renewed every four or five years.

Since we know that of all the constituents of stone there is nothing more permanent than silica, and that the combinations into which this substance enters are numerous and varied, and, moreover, that silicates are capable of being readily manufactured by easy and inexpensive processes, it was natural that some solution of silica should have been amongst the first to suggest itself to the chemist as likely to prove eminently successful as an application for the hardening of stone. Accordingly we find that, as far back as the year 1826, Professor Fuchs, of Munich, proposed an alkaline solution of silica, under the name of soluble glass, for the solidification of stone. Professor Kuhlmann, of Lille, subsequently read a series of papers before the French Academy of Sciences, on the application of water glass (silicate of potash) to the hardening of stone. The great drawback to the use of these alkaline silicates is the efflorescence to which they necessarily give rise. In order to avoid this difficulty, other methods were proposed some years later to the Commission appointed to inquire into the condition of the stone of the Houses of Parliament. Amongst these was a solution of baryta, followed by a solution of superphosphate of lime, which produced a precipitate within the pores of the stone of insoluble phosphate of lime and phosphate of baryta; another was silicofluoric acid in conjunction with baryta, both of which processes were attended with a certain amount of success.

Limestones may also be rendered nonporous by the application of oxalate of alumina, which produces an insoluble precipitate of oxalate of lime and alumina. Any of these processes fill up the pores of the stone with material of a permanent character without giving rise to the production of soluble salts which require to be washed out. The use of organic substances, such as linseed oil, afford considerable protection for a time, but organic matter of this description is liable to be changed by combining with the oxygen of the air. In the case of ordinary painting, it is the oxidation of the oil of the paint that causes the paint to scale off in the course of a few years, the oil being converted into a brittle resinous substance. The rapidity with which gutta-percha, when exposed in thin strips to the influence of light and air, loses elasticity and is converted into a brittle material, affords a good illustration of this oxidation of organic matter. Of materials not belonging to the inorganic or mineral class, one of the least subject to any change is paraffin, and on this account the use of paraffin applied in various ways, sometimes in solution and sometimes in a melted state, has been at various times suggested as a means of preserving stone by preventing the penetration of moisture. We have a striking example of the effect cf climate upon stone in the Egyptian obelisks which, after remaining unaltered for thousands of years in the dry climate of Egypt, are no sooner removed to such an atmosphere as that of London, than they begin to show signs of disintegration and decay, as is more or less the case with all the three obelisks that have been brought away from Egypt, one erected in New York, another in Paris, and a third on the Thames Embankment. Their condition is no doubt, to a considerable extent, due to injuries received whilst they laid neglected on the sands of Alexandria, and partly to such as were unavoidable in transporting them to the several positions they now occupy. The decay that has taken place in the New York obelisk appears to have been very much greater than is the case with the one erected in London. In a paper read before the New York Academy of Sciences, it is stated that exfoliation had taken place to a serious extent, pieces of considerable size becoming detached from the mass. Attempts at preserving the stone from further decay have been made both at London and New York. The method adopted in New York by the advice of Dr. Doremus consisted in the use of paraffin, which was applied in a melted condition (mixed with a little creosote) to the stone, previously warmed by means of a small

portable furnace. In this manner the paraffin could be made to penetrate to a depth of from a quarter to half an inch.

A very popular building stone in New York is that known as "brown stone," which, from its liability to decay, necessitates the use of some preservative process, and the paraffin treatment has been employed upon various buildings in New York with results that have been regarded as successful. With respect to the obelisk, however, the last reports I have seen are not in favour of this mode of treatment. Any process which involves the heating of the surface of the stone, must always be attended with considerable risk of failure.

The obelisk on the Thames Embankment has also been subjected to a preservative process, but of a different kind. Upon its showing indications of being acted upon by exposure to the atmosphere of London, the Board of Works, in 1879, under the joint advice of their engineer and consulting chemist, entrusted the task of coating it with a preservative solution, consisting essentially of a solution of gum resins in petroleum spirit, to the Indestructible Paint Company. The solution was very carefully applied after cleaning the obelisk thoroughly, beginning with a very weak solution, and repeating the application as long as the stone could be made to absorb it. So far, the application appears to have been of service, but a period of eight years is too short a time to allow of any decided opinion being formed as to the durability of such a protective coating.

As regards the palace at Westminster, the decay, after all, cannot be said to have affected its stability as a building; it has been chiefly confined to places underneath string courses, or ledges, which are kept constantly damp by the rain collecting upon, and percolating through, the stone above. Some of the finials have also been broken by the rusting of the iron rods that supported them. What is now being done in the way of preservation, is to coat such projecting surfaces with mastic or cement, so as to allow the rain to flow off freely, without allowing it any opportunity for penetrating the stone, and to remove decayed and imperfect stone, replacing it with sound material.

If care be taken in the selection of stone, it is only under special and exceptional circumstances that it will be considered desirable to resort to methods of preservation, which must necessarily be expensive, and can only be regarded as the best cure for defects that admit of no other remedy.

Artificial Stone.

The numerous attempts that have been made at different times to produce an artificial material that should be capable of being used in the place of natural stone, have resulted in the very general use of concrete, or materials in which Portland cement is the binding material. The closest imitation of natural stone is perhaps that manufactured by Mr. Ransome, who took out his first patent 42 years ago. It was not, however, until 1856 that any successful result attended his experiments, when he found that by the use of calcium chloride, in conjunction with silicate of soda, an efficient binding material could be obtained that, when mixed with sand, would solidify into a hard mass. By the action of calcium chloride upon silicate of soda, an insoluble silicate of lime is formed, leaving a soluble sodium chloride, or common salt, which had to be removed by washing, an operation which, although apparently very simple, proved to be extremely difficult in practice. In spite of the greatest care it was found impossible to wash out the last traces of soluble salt from massive blocks, and consequently the stone was liable to be disfigured by efflorescence. This stone was subsequently prepared by an improved process, but it cannot be produced to compete with the lower price at which substitutes for stone can be made by the aid of Portland cement.

Silicate of soda is readily obtained by boiling flints in a solution of caustic soda under a pressure of 60 lbs. on the square inch; or it may be obtained by simply boiling certain siliceous deposits found in various parts of the world in an open vessel. In certain strata of the lower chalk formation in the counties of Surrey and Hampshire, there are beds which contain silica in this readily soluble condition, some of which, in the neighbourhood of Farnham, will yield as much as from 50 to 70 per cent. of silica by simply boiling with caustic soda.

The Victoria Stone Company has for the last sixteen years been producing a very excellent material as artificial stone, especially adapted for sinks, flagstones, and landings, which is capable of competing successfully with the best Yorkshire flagging. It may be regarded as a fine description of concrete, being produced by binding together granite

siftings, by means of Portland cement. Their principal works are situated near the Groby granite quarries, not far from Leicester, and it is the siftings of the broken granite that are thus utilised. These siftings, after being washed, are mixed with Portland cement in the proportion of three parts of the former to one of the latter, sufficient water being added to cause the cement to set. The surface of the blocks is further hardened by being placed in tanks containing a solution of silicate of soda.

There are other kinds of artificial pavement now manufactured, in the preparation of which broken granite and blast furnace slag are employed, but they all depend principally upon Portland cement as the binding material.

Terra-cotta.

During the last twenty years much attention has been paid to the manufacture of a material to be used as a substitute for stone, which, so far from being of modern origin, is associated with the very earliest history of our race. It is known by the name of terra-cotta. As regards durability, burned clay is capable of resisting the effects of time to as great an extent as any other material used for constructive purposes, of which we have abundant evidence in the specimens of Assyrian and Egyptian antiquities in the British Museum. The use of terra-cotta affords facilities for the production of elaborate designs, the clay model itself being converted by baking into a material more durable than stone. It is much lighter than stone, as compared with the crushing force it will sustain; and by the use of different clays a variety of colours may be obtained. Against these advantages must be considered the difficulties presented in the liability of the clay to shrinkage, both in drying and firing, which, in spite of the greatest care and experience, not unfrequently produces distortion from unequal contraction. To the improved manufacture of this material, a great impetus was given by its being adopted to such a large extent for the Albert Hall and other buildings at South Kensington, the perfection to which it has now attained being, to a great extent, due to the energy and skill displayed by Messrs. Doulton and Co., as well as by other manufacturers. Success depends upon the use of a due proportion of the several materials employed, on the attention paid to the grinding and mixing, and to the care bestowed during the operations of drying and firing.

Fire-bricks.

The plastic clays consist of silica and alumina, chemically combined with water. They are hydrated silicates of alumina, their plasticity depending upon the water that enters into their composition. The water, with which the clay is mechanically combined, can be expelled at a temperature a little above that of boiling, without detriment to its plasticity, but the whole of the water it contains cannot be driven off without raising the temperature to dull redness. Silica, alumina, and lime are all separately very infusible substances, and are capable of resisting exposure to very high temperatures without softening. It is on account of its extreme infusibility that lime is found to be the most suitable material for the cylinders upon which the oxyhydrogen flame is made to impinge to produce a brilliant light, the intensity of the light being due to the extremely high temperature to which the lime is raised. Lime, however, from its want of cohesion, could never be brought into general use for such purposes as fire-clay is employed, and this is also the case as regards silica, which requires the addition of some substance of a basic character with which it will unite, and so cause the particles to bind together.

The nearest approach to the use of silica alone as a fire-brick is in the well-known Welsh brick, made from the Dinas rock in the Vale of Neath. This material, before it was made into fire-bricks, had long been used for repairing the furnaces at the copper works of South Wales, for which purpose its peculiar property of expanding when subjected to the influence of high temperature, instead of contracting (as is the case with ordinary fire-clay), renders it particularly suitable, the cementation of the bricks being facilitated by the increase of temperature. In order to make bricks of this Dinas rock (which occurs in various conditions, from that of a firm rock to that of disintegrated sand), it is necessary to mix with it about one per cent. of lime. These Dinas bricks will stand very high temperatures, but they are more friable than ordinary fire-bricks, and will not resist to the same extent the action of basic substances, such as furnace slags containing much oxide of iron. The bricks are porous, readily absorbing moisture, hence it is necessary that furnaces built of these bricks should be gradually heated, the bricks being liable to crack if sufficient time is not allowed for driving off the moisture.

The composition of the clay used for fire-bricks is a question of considerable importance, inasmuch as its quality depends greatly upon its chemical constituents, although its power of resisting fusion, when exposed to intense heat, is affected by its mechanical condition. The same materials, when mixed together in the form of a coarse powder, will require a higher temperature to fuse them than would be the case if they were reduced to a fine state of division. For the manufacture of fire-bricks the raw clay is ground between rollers or under edge stones, or reduced to powder by means of a Carr's disintegrator, which consists of large cylinders constructed of wrought iron bars revolving rapidly in opposite directions. The clay is then kneaded with water, old bricks or other fired ware reduced to a coarse powder, technically known as "grogg," being mixed with the raw clay. This admixture of previously burnt clay renders the bricks less liable to shrink, and enables them to bear a much higher temperature without fusion than would be the case if only new clay were employed. The qualities required in fire-bricks are—

1. That they should bear exposure to intense heat for a long period without fusion.

2. That they should be capable of being subjected to sudden changes of temperature without injury.

3. That they should be able to resist the action of melted copper or iron slags.

It is not to be expected that any one description of brick should exhibit all these qualities to the fullest extent, and, it is therefore essential that, in selecting the kind of fire-brick to be used, due regard should be paid to the particular purpose for which it is required.

A fire-brick like the Dinas, containing 98 per cent. of silica, will bear exposure to a higher temperature than a Stourbridge, but it will run down sooner than the Stourbridge when in contact with melted iron slag.

Gannister is the name given to a fine grit which occurs under certain coal beds in Yorkshire, Derbyshire, and South Wales, which is especially adapted for lining cupola furnaces; the peculiar black gannister from the neighbourhood of Sheffield is in great request for this purpose, as, owing to the large quantity of silica it contains (from 80 to 90 per cent.), it will stand high temperatures without shrinking. The Lee Moor bricks are manufactured at Plympton, in Devonshire, from the coarser portions of decomposed granite, separated from the china clay during the process of washing. These bricks contain a large proportion of silica, and are very infusible, their power of supporting exposure to very high temperatures being increased by the coarseness of the particles of disintegrated granite, of which they are composed.

Fire-bricks are also made of siliceous clays from granitic deposits in other parts of Devonshire. The material employed for such bricks, as well as for the Dinas, differs materially in its character from what is ordinarily understood by the term fire-clay, as used in the manufacture of such well-known bricks as the Stourbridge, Newcastle, or Glenboig; the quality of which, as regards their chemical composition, depends upon the relative proportions of silica and alumina, and their freedom from iron oxide and alkaline salts, the presence of which tend to render the clay more fusible.

Miscellaneous.

FLOWER FARMING AND PERFUME MANUFACTURE IN SOUTHERN FRANCE.

For nearly a century the culture of flowers on a large scale, and the manufacture of perfumes and essences have formed a special and lucrative industry in Southern France. The principal district in which the manufacture is carried on is at Grasse, in the Department of the Alpes Maritimes; but it is also conducted on a more or less extensive scale at Sommières, Nîmes, Nyons, and Seillans. The descriptions of flowers principally grown, and their season of harvest, are the violet, jonquil, and mignonette, which are usually gathered in February, March, and April, although, in mild moist winters, the violets commence as early as December; roses and orange blossoms, with thyme and rosemary in May and June; jasmines and tuberoses in July and August; lavender and spikenard in September, and the acacia in October and November. The flower harvest covers, therefore, about three-fourths of the year, but the season of greatest activity is May and June, when the roses and orange blossoms are gathered. Thyme, rosemary, and lavender, are among the minor products grown principally by small farmers of the grape and olive, who have at home the simple apparatus for distilling the flowers, and they produce a more or less inferior class of essences, which are used to dilute and adulterate the superior essences produced at the large establishments in towns and villages.

Consul Mason, of Marseilles, in a recent report upon flower farming in Southern France says that the conditions of industrial success in flower growing can be best studied by a specific example, and he quotes the case of a plantation at Seillans in the department of the Var. This farm is about twenty-three acres in extent, and is situated on the southern slope of the hills, about 2,000 feet above the level of the Mediterranean, and at a distance of twenty miles from the coast. The calcareous soil was originally naturally poor and thin, and the olive trees which had occupied the ground for a century or more prior to 1881, yielded but scanty and unsatisfactory returns. The slope of the surface was so steep that the waters of a spring which flows from the rocks above the track could be but imperfectly utilised for irrigation, and the land was regarded as practically worthless. In 1881 the proprietor caused the olive trees to be removed, and the land prepared for flower culture. The ground was first dug up to a depth of four feet, the larger stones removed and built into sustaining walls for the terraces into which the surface was divided and levelled. Along the upper margin of each terrace a shallow ditch was cut, connecting with transverse channels which supply the spring water for irrigation. The abruptness of the slope will be indicated by the fact that, on the tract of eighteen acres, the terrace walls required to produce a series of level or gently sloping surfaces are over 2,000 yards in length. Thus terraced, the tract yielded about seventeen acres of prepared ground for planting. In the autumn of 1881, 45,000 tufts of violets and 140,000 roots of the white jasmine were planted. The following spring the remainder of the ground was planted with roses, geraniums, tuberoses, and jonquils, and a laboratory erected for the manufacture of perfumes. The position proved to have been well chosen, as the flowers grew vigorously and well, and in 1885, the fourth year after planting, this farm, which had previously yielded a rental of £23 a year, produced perfumes valued at £8,630, giving a net profit of £1,553. This is sufficient to illustrate how lucrative flower farming may become in favourable districts, and under good management. From observation at Seillans and in the neighbourhood of Grasse, where perfume flower growing is the leading industry, Consul Mason says that the essential conditions appear to be an altitude of from five hundred to two thousand feet. Flowers grown on such elevated positions are said to be richer in perfume than similar varieties which bloom in valleys and lowlands; a soil rich in calcareous elements, a situation sheltered from cold northern winds, and not subject to the white frosts which in spring and autumn affect the damp lowlands. In countries like Southern France, where the rainfall is always scanty, and often wanting entirely from May until September, irrigation is essential to the culture of flowers as well as every other crop. It is said the perfume growers and distillers on the Mediterranean coast attribute their success not less to the peculiar climate of Provence than to their knowledge of every detail of the industry, a knowledge acquired by more than a century of experience, and transmitted from generation to generation. One essential principle in perfume culture is that all fancy and "improved" varieties of flowers are discarded, and the natural, simple, old-fashioned kinds are exclusively grown. The roses on the slopes of Seillans are the common pink ones, and the single wild violet is preferred to all the larger artificially developed varieties. Only the white jasmine is used, the yellow and less fragant variety appearing to be either discarded or unknown. Jasmine plants are set in rows about ten inches apart, and are closely pruned. Roses are grown on the lower terraces, and are also cut low, and the ground between the plants heavily manured. After the roses have been gathered the stem is cut to within a few inches of the ground to preserve for the next season the entire vigour of the plant. During the harvest season traders or "middle men" go through the country every day with waggons collecting flowers from the farms, for which they pay prices varying according to the extent of the crop and the demands of the market, their loads are hurried to the nearest manufacturer, and delivered while the flowers are still fresh and crisp. The flowers are usually gathered in the morning, as soon as possible after the dews of the preceding night have disappeared. The manufacture of perfumes includes the making of pomades and oils by the process of absorption, and of essences and essential oils by distillation. Every complete establishment is provided with apparatus for all these processes. Pomades are the commercial vehicles for absorbing and transporting the perfumes of the jonquil, tuberose, jasmine, and other species of flowers. A square frame or *chassis* of white wood, about twenty inches by thirty in size, is set with a pane of strong plate-glass. On either side of the glass is spread a thin even layer of grease—two parts lard to one of tallow—which has been purified and refined by previous boiling and straining. Thus prepared, the frames are piled up in ranks, six or seven feet high, to await the season of each special flower. When the blossoms arrive, the petals are picked from the stem, and laid so as to cover the grease in each frame. These being again piled so as to rest upon their wooden edges, which fit closely together, there is formed a species of tight chambers, the floors and ceilings of which are of grease, exposed to the perfume of the flower leaves within; the grease absorbs the perfume, the spent flowers are removed daily, and fresh ones supplied, and this process goes on from two to four, or five months, according to the desired strength of the pomade, which, when sufficiently charged with perfume, is taken from the glass with a wide thin spatula, and packed in tin cans or *stagnons* for export. By these methods the delicate odours of flowers are extracted, and retained for transport to distant markets, where

the grease, being treated with alcohol, yields the perfume to that stronger vehicle, and produces the floral waters and extracts of commerce. Coarse pomades are made by boiling the flowers in the grease, and subjecting the residue to pressure. The spent pomades are used for toilet purposes, and in the manufacture of fine soaps. The process of preparing perfumed oils involves the same principle, except that instead of solid grease, superfine olive oil is used. With this oil, pieces of coarse cotton fabric are saturated, which are then spread upon wire netting framed in wooden *chassis* about three feet by four in size. The flowers are spread upon the saturated cloths, and the frames piled one upon another, so that the perfume of the flowers is absorbed, as in the previous process. Essences and scents are produced by ordinary distillation, in which the flowers are boiled with water in large alembics; the vapour carries off the perfume, and is condensed in adjoining copper tanks. Some of the retorts used for this purpose are of sufficient size to receive at once half a ton of fresh flowers, with the requisite water for their distillation. When scents are to be produced, alcohol is used in the distilling tank to receive the perfumes. By skilful combinations of the perfumes of different flowers, sometimes with the addition of chemicals, a large variety of scents, such as "patchouli," "jockey club," &c., are produced at the original laboratory. The work of the manufactories is largely done by women, who earn from tenpence to one shilling for a day's labour of ten hours, and during the busy season of roses and orange flowers, they earn half as much more by working until midnight, or even later.

NEW PETROLEUM SUPPLIES.

The United States, which is only now becoming reconciled to the rivalry of Russian petroleum, is menaced by serious competition in a fresh quarter, nearer home. In Venezuela the petroleum deposits of Lake Maracaybo, which have long been known for their copiousness, are at length being opened up by capitalists, and there are rumours, reported by the American Consul, Plumacher, that the Rothschilds are likely to secure a monopoly of the affair. Lake Maracaybo is situated in the northern part of Venezuela, and by means of the Gulf of Venezuela, has direct communication with the sea. The surrounding country, having an area of many hundred miles, is saturated with petroleum and asphalte, which flows in streams through the dense forests, and emits inflammable gas, which often bursts into sheets of flame similar to those which have been a phenomenon in the Caspian region for thousands of years. While the petroleum gas burning at Baku has secured that country the appellation of "The Region of the Eternal Fire," the petroleum gas perpetually flickering on the bar and along the immediate coast of Maracaybo has earned for the phenomenon ever since the Spaniards discovered and conquered the country, the title of "The Infernal Fire." According to Consul Plumacher, one of the streams of oil tested by a traveller was found to flow at the rate of nearly 6,000 gallons a day, the whole of which was wasted upon the sandy soil. The Venezuelan oil appears to occupy a midway position between the crude article extracted in the United States and Russia, yielding 50 per cent. of illuminating oil, or kerosene, of high quality, as compared with the 70 per cent. of the former, and the 30 of the latter. The deposits, however, have one immense advantage over both, being situated on the coast of the lake—which is practically an inlet of the sea—while those of the United States are distant 400 or 500 miles from the refineries on the coast, and those of Baku 560 miles from the port of Batoum. No engineering obstacles exist to the extraction of the oil, which, when properly bored for, may take rank with those of the United States; and to encourage the development of the industry the Venezuelan Government has imposed a duty of 15½d. a gallon, which is three times the wholesale price of American or Russian oil in the English market. With such a crushing duty as this to protect the home article, there ought to be no difficulty in expelling American oil completely from Venezuela.—*Engineering.*

TECHNICAL INSTRUCTION.

The Cobden Club is issuing a digest of the Report of the Royal Commission on Technical Education, with a preface by Sir Bernhard Samuelson, the Chairman of the Commission, and the work is just now of sufficient interest to merit a few preliminary words of notice. Sir Bernhard has availed himself of the opportunity to consider how far the recommendations of the Commission have been carried out by various agencies, and to review the question by the light of recent experience. It is worth while to remind the reader that those recommendations included the teaching of drawing in all elementary schools, the inclusion of handicraft instruction as a specific subject earning a grant, the teaching of the elements of agricultural science in rural schools, and the efficient teaching of science in training schools for teachers. Hopes were also expressed that technical scholarships might be founded by private liberality, that employers of labour and trade unions alike would encourage the study of technical science by the young, and that schools for instruction in agriculture might be founded. The first step taken by the Government to carry out any of the recommendations is the Technical Education Bill just introduced. Of this Bill, as is natural, Sir B. Samuelson warmly approves, regarding it as a first attempt to promote technical instruction throughout

the length and breadth of the land. As regards progress through agencies other than those supported by the State, it is noted that many schools for higher technical education are now in fair working order, and others are being established. As these cannot be self-supporting, Sir Bernhard suggests that they might well receive Government aid, a result, perhaps, rather to be wished than expected. An encouraging sign of the growing interest in the subject is the foundation of the new association for the promotion of technical education; and those who, like Sir Bernhard Samuelson, have laboured long and earnestly to convince the public of the need for instruction in the arts and manufactures, may well look with satisfaction at the progress which has already been made, and at the hopeful signs of further progress in the immediate future.—*Times*.

Correspondence.

THE KOLA NUTS.

Mr. Thomas Christy writes, in reference to some points raised in the discussion on the paper read by Sir Augustus Adderley before the Society of Arts, that he is now enabled to report that planters in the Dutch East Indies are largely availing of this system of coffee hulling in London, and are greatly benefited financially. From Central America coffee is coming here to be prepared and sold from the warehouse. Mr. Christy also draws attention to some remarks on kola, made by Dr. Thomas Oliver, and reported in last week's *Lancet*. Dr. Oliver thinks favourably of the effects of kola paste in the treatment of heart disease. "Its efficacy as a nervine tonic has long been recognised in those places where the fruit abounds. By the inhabitants of such it is employed as an antidote to alcohol; men who are so intoxicated as to be rendered incapable of walking straight, are said to become sober and recover their normal gait from within half an hour to an hour after taking the drug." Mr. Christy endorses Sir Augustus Adderley's opinion that kola will be a very advantageous crop for our colonists to grow, and adds that, after searching the bills of entry, he learns that about 5½ tons of kola nuts were received in Europe last year, that the stocks are exhausted, and the demand is daily increasing for kola paste.

General Notes.

The Industrial Union.—It is announced that the United States of America have joined the Industrial Union for the International Protection of Industrial Property; the date of the accession being fixed for May 30 of this year. The present members of this Union are Belgium, Brazil, France, Guatemala, Great Britain, Italy, Mexico, the Netherlands, Norway, Portugal, Paraguay, Roumania, Salvador, Spain, Sweden, Tunis, the United States, and Uruguay. By the terms of the Union a patentee in any one country can also patent his invention in any of the others, provided he applies for his patent in the latter within six months after he has applied for it in the first country, and complies, of course, with the conditions of the Patent-law in the particular country in question. Similar provisions are made for the protection of trade-marks. The convention itself dates from 1883, and was joined by Great Britain in 1884.

The Condition of Russian Workmen.—The *Eisen Zeitung* has recently given some details illustrating the low scale of wages in Russia. In large sugar factories, for instance, a certain amount of food is allowed to each workman, but by abstention from taking the full quantity he can get the equivalent in money of the portion thus economised. It is, however, remarked that the physical injury resulting from this arrangement is by no means compensated by the pecuniary allowance thereby obtained. The average wages, in addition to food, amounted in such cases to about 18s. 6d. per month. Sleeping accommodation of a primitive character is likewise provided in some cases.

Poisonous Colours.—The use of poisonous colours in the preparation of articles of food or confectionery is prohibited in Germany by an Act which has received the Imperial assent. The substances indicated are colours and colour preparations containing antimony, arsenic, barium, lead, cadmium, copper, quicksilver, uranium, zinc, tin, gamboge, coraline, or picric acid. The coverings used for holding or wrapping articles are subject to the above general regulations; but exceptions are made for sulphate of barium, coloured baryta lacquers (free from carbonate of barium), chrome oxide, copper, tin, zinc, and their alloys (when used as metallic colours), cinnabar, oxide of tin, sulphuret of tin (when used in mosaic gilding), and colours burnt into the glass, glaze, or enamel of receptacles, as well as those used in painting the outside of packages, &c., composed of impermeable substances. The prohibition of the first-named group of noxious ingredients extends (with exceptions generally corresponding with those already named) to cosmetic preparations, or dyes used for the skin, hair, or mouth, as well as to toys, picture books, flowerpot frames, &c. Special restrictions against the use of arsenic are made with regard to printing and lithographic work, as well as with respect to wall paper, carpets, furniture stuffs, paints, &c.; a small maximum quantity being permitted in textile articles.

Journal of the Society of Arts.

No. 1,812. Vol. XXXV.

FRIDAY, AUGUST 12, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

BUILDING MATERIALS.

By W. Y. Dent, F.C.S., F.I.C.

Lecture III.—Delivered February 28, 1887.

Of all natural productions, there is not one that is of greater importance to the builder, or that is applicable to so many manufacturing purposes, as limestone, this being the general term by which all rocks may be designated which have carbonate of lime for their basis. These calcareous deposits belong to several geological formations, and differ materially from each other both as regards their chemical composition and their physical character, being sometimes in the form of a dense hard rock, as is the case in what is known as carboniferous or mountain limestone, many of the beds of which are of great thickness, consisting of nearly pure carbonate of lime. In the limestones of the Lias, on the contrary, the carbonate of lime is associated with silica and alumina in proportions varying from 10 to 20 per cent., of which we have examples in the limestone of Abershaw, in Glamorganshire, the Barrow limestone in Leicestershire, and the limestone of Warwickshire. These Lias deposits consist of comparatively thin layers of hard limestone separated by others of a more argillaceous character, or shales, containing various proportions of carbonate of lime. The Lias district extends from Lyme Regis, in Dorsetshire, to the north-east of Yorkshire, the limestone being worked chiefly in the counties of Dorset, Warwick, and Leicester, yielding, when calcined, the best description of hydraulic lime. In the chalk districts of Kent and Surrey, we have in the upper white chalk a soft description of comparatively pure carbonate of lime, and in the grey chalk which lies immediately below it, we have a carbonate of lime of a somewhat harder description, associated with a small proportion of argillaceous matter.

One of the most wonderful and curious formations of limestone is that which results from the agency of the coral polype, which possesses the power of abstracting carbonate of lime from the water of the ocean, and is thus enabled in warm climates to construct those enormous reefs which, in some cases, extend for hundreds of miles in the Pacific and Indian seas. The coral, as produced, is carbonate of lime, soft and porous at first, but it gradually becomes hard and compact, so much so that it is capable of being used as a building stone, as is the case in some of the South Sea Islands. In the course of its formation, all kinds of marine *débris* get mingled with it, which, when cemented together, produces a rock that bears a resemblance to some descriptions of the older limestones. The sediment resulting from the trituration of the coral when deposited in sheltered water channels, produces a material similar in appearance to chalk, whilst the coral from reefs that have been upheaved by volcanic agency, is found to be of a sparry or crystalline character. These coral reefs occur in every stage of development, from the coral that is daily growing to that of a compact solid mass resembling some of the softer marbles, and thus, owing to the changes that take place from the action of the waves, and to the elevation or depression of the ocean bed, a coral reef eventually becomes a more or less compact limestone, so that as the result of the labours of the coral polype, we have deposits which represent several varieties of limestone.

Carbonate of lime is found in a state of chemical purity in rhombohedral crystals, as Iceland spar, which (as is well known) possesses the property of refracting light in a peculiar and remarkable manner, and has hence received the name of double refracting spar. Carbonate of lime is also found in six-sided prisms, known to mineralogists as aragonite, so called from Aragon, where it occurs in large mackled crystals, in the gypsum deposits of that part of Spain. The form of crystal assumed by carbonate of lime depends upon the circumstances under which

the crystallisation takes place, such as temperature (the tendency to the formation of aragonite being greatest when it crystallises from warm solutions), the degree of concentration of the solution, and the presence of foreign substances. Its purest form as a rock is that of white marble, the coloured marbles containing iron, manganese, and carbonaceous matter. The proportion which the carbonic acid bears to the lime is as 22 to 28, lime itself being an oxide of calcium. Calcium is a light malleable metal, somewhat harder than lead, tarnishing rapidly on exposure to the air by the absorption of oxygen; when heated to redness it burns with a brilliant, scintillating white light. It has not received any practical application in the arts, and is only capable of being produced in very small quantities for experimental purposes.

By exposure to a red heat, under ordinary circumstances, carbonate of lime is decomposed, the carbonic acid is driven off, and the lime remains in an uncombined or caustic state. The time required for completing this decomposition depends upon the character of the limestone, and the circumstances under which the "burning" (as it is termed) of the limestone is conducted.

If carbonate of lime be heated in a confined space, such as a close retort, where there is no possibility of the escape of carbonic acid, complete decomposition cannot take place, however high the temperature may be raised; the limestone becomes surrounded with an atmosphere of carbonic acid, and until this is removed its further decomposition is arrested. Chalk under such circumstances may assume a highly crystalline condition, and thus in nature we find dull granular limestones that have been altered in their character by the intrusion of an igneous rock; we have an example of such conversion in Rathlin Island, off the north coast of Ireland, where two basalt dykes ascend through the chalk, converting the latter into a fine granular marble. Experiments were made many years ago which proved that when the carbonic acid liberated was rapidly carried off by a current of steam or air, the rapidity with which the limestone was decomposed was increased, a fact which it may be well to remember in discussing the merits of different modes of calcining. The process of "lime burning" is carried out in several different ways, in comparing the advantages of which, it is necessary that the various circumstances that bear upon the question, such as the character of the stone and the amount of lime that can be disposed of in a given time, should be considered.

Whether the operation be carried out in the simplest manner, or in the kilns constructed on the most scientific principles, much will still depend (both as regards the quality and quantity of the lime produced) upon the kilnsman, for it is only by constant observation from day to day that the eye becomes capable of judging whether the proper temperature has been reached, or that a correct opinion can be formed as to the effects produced by the various disturbing causes which exert an important influence upon the working of a kiln, such as its size, shape, the character of the limestone, the quality of the fuel, and the state of the atmosphere.

The kilns usually employed vary as regards size and shape in different districts, consisting generally of inverted cones or ellipsoids, into which layers of limestone and fuel are alternately thrown. When worked continuously as running kilns, the lime is periodically withdrawn from below, fresh quantities of stone and fuel being filled in at the top. It is obvious that the consumption of fuel must be much less when worked continuously than is the case when, after every charge, the kiln is allowed to cool down before the lime is removed. It is very difficult (even when every care is taken) to obtain from ordinary kilns, when worked continuously, a uniformly satisfactory product; the temperature is not sufficiently under control, and sometimes increases more rapidly in one part of the kiln than it does in another; or not unfrequently a block occurs, and a mass of stone and fuel remains immovable for a considerable time, and when this stoppage is overcome the mass gives way, and a quantity of lime and half-calcined limestone comes down together. Owing to these uncertainties, which no precautions can entirely guard against, when it is essential that the limestone should be equally and thoroughly calcined, the kilns are worked on the intermittent system, the charge being put in at once, and the kiln allowed to cool down before the lime is removed, the extra cost in fuel being more than compensated for by the superior quality of the lime obtained.

In the chalk districts, in which what is termed "flare lime" is produced, to distinguish it from the lime as obtained from the kilns to which I have referred, the process is

carried out in a somewhat different manner. Only a small quantity of fuel is mixed with the chalk, its calcination being chiefly effected by the flames of the burning coal placed below. A fire-place is constructed in the outer wall of the kiln of brick arches, these arches being continued within the kiln by piling up large blocks of chalk, over which the remainder of the chalk is filled in; the fire below the arches is lighted, and when the whole mass has attained the requisite temperature (which is determined by the experienced eye of the kilnsman), the fire is allowed to burn out, and the lime, when cold, is withdrawn. These kilns will turn out about thirty tons of lime with a consumption of about nine tons of coal. A variety of kilns have from time to time been proposed with the view of diminishing the consumption of coal, few of which have been constructed on sounder principles, or have been more successful in attaining the desired object, than those of Hoffmann, which are frequently alluded to under the name of circular or ring kilns.

The great economy, as regards fuel, effected by the use of kilns of this description, is obtained by causing all the air entering the kiln to pass over the lime that has already been calcined before it reaches the burning fuel, and the products of combustion, together with the carbonic acid and vapour of water from the limestone, to pass over the fresh limestone before reaching the chimney. By the arrangement adopted, the air is raised to a high temperature before it reaches the fuel, by taking up the waste heat from the hot lime, which in ordinary kilns is entirely lost. Combustion takes place under the most favourable conditions, the fuel being consumed in the most perfect manner, with scarcely any escape of smoke. The heat recovered from the gases evolved is sufficient to raise a portion of the limestone almost to dull redness before it meets with the burning fuel, and the amount of heat that escapes is little more than what is required to create a sufficient draught in the chimney. The kiln consists of a flat-roofed circular or elliptical tunnel, divided into twelve or more chambers, placed round a central chimney shaft; the flues which connect each chamber with the central chimney are so arranged as to be capable of being closed at pleasure. Two adjoining chambers of this series are opened (generally every day), in one of which the operation of charging with fresh limestone is going on, whilst the lime is being taken from the other. The air entering at these open chambers passes through four chambers filled with hot lime, which it cools down, becoming more and more heated before it reaches the two or three chambers in which the fuel is being consumed, and afterwards passes through the remaining chambers of the series filled with fresh limestone, finally reaching the chimney through the flue of the last chamber that had been filled on the previous day. The fuel used is small coal, which is thrown in at the top of the flat roof of the kiln in very small quantities at a time, through openings communicating with shafts that are left to receive it when stacking the limestone. These openings are closed by loose covers that are only lifted at the moment when the coal is put in, or for the purpose of observing how the kiln is working. The kilns are constructed on a very large scale, each of the chambers, in a kiln which has now been worked for 20 years in North Wales, being capable of turning out 20 tons of lime. The building of such kilns involves a large outlay of capital, and it is necessary that they should be kept going constantly and regularly, as the kiln after having been once lighted is never allowed to go out, every chamber taking its turn for the operations of filling, firing, and discharging. It is evident under these circumstances that kilns of this description are most suitable for large works, and where there is a constant demand for the lime produced. Another description of kiln has recently been brought out for burning lime and cement, known as the Dietzsch kiln, which is still more economical as regards the consumption of fuel than Hoffmann's, inasmuch as there is less waste of heat, owing to the portion of the kiln in which calcination takes place never being allowed to cool except for repairs. This kiln consists of a vertical shaft, divided horizontally into two parts, which are connected together by a short horizontal chamber. The upper part of the shaft is kept charged with the raw material, which gradually falls by its own weight into the horizontal chamber, from which it is passed on as required, by means of shovels, to that part of the lower portion of the shaft in which its calcination is completed, and which is maintained at a high temperature, by the continual addition of fuel (in small quantities at a time), through apertures made for this purpose and for stoking. The calcined material is allowed to fall into a cooling chamber, through which air is supplied to the kiln. By this arrangement the cement or lime does not remain in contact

with the fuel for a longer time than is necessary for its calcination, and no heat is wasted in having to warm up the walls of the kiln after every discharge. The air supplied to the kiln is warmed by passing over the calcined mass which it cools, whilst the gases produced by the combustion of the fuel give up the greater portion of their heat to the freshly charged material before escaping from the top of the shaft. It is stated that in a kiln of this description a ton of cement does not require more than from two to three cwt. of small coal for its calcination. The Dietzsch kiln has only quite recently been introduced into this country. Its construction is simple, but it requires more constant attention than ordinary kilns.

It has been proposed to use gas as the fuel for lime burning, a plan which has the advantage of not bringing the lime into contact with coal or coke, and consequently produces a lime of better colour. Although attempts have been made to adopt this process on a considerable scale, I am not aware of their having been brought to a successful issue in this country, owing to the difficulty that has been experienced in so regulating the supply of gas and air as to insure the ignition of the mixed gases taking place in such a manner as to produce a uniform temperature throughout the mass of limestone, and in making the kiln gas-tight. It may be anticipated that, with more experience, these difficulties will disappear, but at present the Hoffmann kiln for lime burning is entitled by long experience of its merits to be considered as one of the best, both as regards efficiency and economy.

When lime has not been properly calcined, and will not slake with water, it is termed "dead burnt," which may arise from two causes: from insufficient burning, when the limestone, instead of being entirely caustified, has only been changed into a basic carbonate consisting of two equivalents of lime and one of carbonic acid, one-half only of its carbonic acid having been expelled; this basic carbonate, on the addition of water, instead of forming a hydrate of lime, and being converted into a fine impalpable powder, attended with the production of a large amount of heat, is changed with but comparatively little elevation of temperature into a mixture of hydrate and carbonate.

In the case of hydraulic limes which contain a considerable amount of silica, this "dead burning" may arise from the limestone having been subjected to too high a temperature, whereby a partial fusion of the silicate of lime formed has been produced, giving an impervious coating to the inner portions of the stone, which retards the further evolution of carbonic acid. On this account the eminently hydraulic limes require to be carefully calcined at as low a temperature as practicable, and hence we not unfrequently find that lias lime has been imperfectly calcined. Pure limes, if subjected to too high a temperature, exhibit somewhat less tendency to combine with water than is the case with lime that has been properly calcined.

Caustic lime unites with water with great energy, so much so, as to evolve a very considerable amount of heat. When water is poured upon a piece of well-burnt pure lime, heat is rapidly generated, and the lime breaks up with a hissing crackling noise, the whole mass being converted in a short time into a soft impalpable powder known as "slaked lime;" chemically speaking, it is a hydrate of lime, that is, lime chemically combined with a definite amount of water. In the process that is termed slaking, one equivalent or combining proportion of lime unites with one equivalent of water, or in actual weight 28 lbs. of lime combine with 9 lbs. of water (being nearly in the proportion of 3 to 1) to form 37 lbs. of solid hydrate of lime; the water loses its liquid condition, and it is to this solidification of water that the heat developed during the process of slaking is partly due. In the conversion of a solid body into a liquid, as is the case in melting ice, a certain amount of sensible heat is rendered latent, and in re-assuming the solid condition this amount of heat is again rendered sensible. In slaking lime, however, a much larger amount of heat is developed than is derived from the solidification of water, which further development of heat is to be ascribed to the chemical action which takes place between the water and the lime; for chemical combination, in by far the greater number of cases, is attended with evolution of heat. The heat thus generated may be perceptible to the senses or not, according to circumstances—thus, for instance, when carbonate of lime is decomposed by the addition of an acid, the heat developed may not be observed, because a large proportion is absorbed in the conversion of the carbonic acid from the solid form in which it existed as carbonate of lime into a gaseous state.

The heat generated by slaking lime has been made use of as a perfectly safe means of

obtaining coal in fiery mines without the necessity for using gunpowder or any other explosive. A hole is bored in the seam of coal about 3 feet in length, and 2½ inches in diameter, into which is inserted a perforated iron tube of about half-an-inch in diameter, covered with a strip of canvas in order to prevent the perforations being closed by particles of lime. The hole is then nearly filled, by putting in a number of short cylinders of highly compressed lime in which a groove is left to receive the iron tube, the charge being completed by six inches of well-rammed clay tamping; water is now forced down the iron tube, and in a few seconds the lime begins to swell, producing a quantity of steam under considerable pressure, which tends to crack the surrounding mass of coal. The temperature never exceeds 800° Fahr., so that in the most fiery mines there is never sufficient heat generated to give rise to an explosion.

The manner in which the process of slaking lime is conducted is a matter of considerable importance, because if this operation is imperfectly carried out, the plaster made from such lime will be liable to blister, owing to the subsequent slaking of small particles of lime still remaining in a caustic state, and these blisters will not unfrequently make their appearance after the lapse of a considerable time. All "rich" or "fat" limes (as those limes are termed which are obtained from pure limestones) may be slaked by mixing with a sufficient quantity of water to reduce the whole to a thick pulp, and are not in any way injured by remaining in this condition for a considerable period. In the preparation of plaster for fresco painting, it is customary to employ lime that has been kept for a long time in the state of thick paste, so as to secure the hydration of every particle; for it is well-known that the smallest portion of unslaked lime would be fatal to the plaster as a suitable material for the ground of any decorative work of art.

With the eminently hydraulic limes, on the contrary, it is necessary to adopt a different mode of proceeding, inasmuch as it is requisite that care should be taken, in slaking limes of this description, that too large a quantity of water should not be employed.

The energy with which hydraulic limes combine with water is not nearly so great as is the case with pure limes, and if too much water be added, and the lime is flooded, the slight amount of heat generated is absorbed. If limes of this description be allowed to remain for any length of time in a pasty condition, hydrated silicates of lime and alumina begin to be formed, and if these silicates be disturbed and broken up, the power of the lime to set subsequently is diminished. In slaking hydraulic limes no more water should be used than is necessary to secure hydration. The slaking of such lime is carried out in practice by sprinkling water over a heap of lime, and covering it over with the sand that is intended to be mixed with it when converting it into mortar, the covering of sand serving to retain the heat that is developed, so as to enable the process of slaking to be carried out slowly throughout the mass.

By exposure to air caustic lime is slowly converted, without much elevation of temperature, into a coarse powder, consisting of a hydrate and carbonate of lime.

Mortar consists of a mixture of slaked lime and sand, in the condition of a thick paste, which is spread in thin layers between bricks or stone for the purpose of cementing them together; the effect of the sand is to increase the points of attachment, and to render the mortar open in its texture, hence it is that the more irregular and angular are the particles of sand the better is it adapted for the purposes of mortar making. In mortar required for plastering it is necessary that the sand used should be free from salt, and that no brackish water should be employed, on account of its containing deliquescent salts, which have a great tendency to absorb moisture, and consequently to render the plaster always liable to become damp.

The hardening of mortar is due to several causes which act collectively. In mortar made from pure or rich limes the first setting is due simply to the evaporation of the water, and to the production of minute crystals of hydrate of lime; this hydrate then slowly absorbs carbonic acid from the air, the rapidity of this absorption necessarily decreasing in proportion to the difficulties presented to the free access of air. This being the case, it is manifest that pure limes are not suitable for mortar to be used for thick massive walls, or in places where it is likely to be exposed to the action of water. It is a well-established fact that, in very heavy masonry, mortar made from pure lime may remain for an almost indefinite period in its original soft condition. In the case of mortar made from hydraulic limes, it is necessary that the mixing of the mortar should be com-

pleted as rapidly as is compatible with the thorough incorporation of the materials, and that it should be used as soon as practicable after having been mixed, for if mortar of this description be put aside for any length of time, its setting properties are deteriorated.

The pure limes are undoubtedly the most effective when lime is required for disinfecting or sanitary purposes, as, weight for weight, they contain more lime than the hydraulic limes, but for the use of the builder there can be no question but that those which partake more or less of the character of hydraulic lime are most suitable; the mortar of such lime sets quicker and much harder than is the case with mortar made from the purer descriptions of lime. It is on this account that the grey Dorking lime made from the lower chalk is preferred for building purposes to that made from the upper chalk. Mortar for hydraulic purposes may also be made by mixing with the pure limes calcareous clays or shales, which have been so altered by the agency of heat that the silica they contain has to some extent assumed the condition of soluble silica. The mortar which was held in such high estimation by the Romans consisted of lime mixed with puzzuolana, so named from a small town at the foot of Mount Vesuvius, in the neighbourhood of which it was first obtained. It is also found in other localities which have been subjected to volcanic eruptions. This puzzuolana is an altered felspathic tufa, the silica of which has been so changed in its character as to be in a more or less soluble condition.

Trass is a material similar in its character to puzzuolana, obtained from the pits of extinct volcanoes in the valleys of the Rhine, between Mayence and Cologne, as well as in various parts of Holland. It is held in high reputation by Dutch engineers, the name trass being derived from a Dutch word signifying a binding or adhesive substance.

There is a great want of uniformity in the chemical composition of these volcanic products, which necessarily gives rise to uncertainty in the composition and character of the supplies obtained, and their use is now to a great extent superseded by the substitution of hydraulic lime or cement.

Hydraulic Cements.

The first hydraulic cements made in this country were obtained by burning natural cement stones, a patent having been taken out in 1796 for the preparation of what was improperly termed "Roman" cement from the calcareous clay nodules known by the name of septaria, which are obtained in considerable quantities on the Kentish and Essex coasts, the chief supplies being procured from Isle of Sheppey and the neighbourhood of Harwich, were they are dredged up from the sea at low water. The composition of these nodules varies considerably, but they may be regarded generally as consisting of from about 50 to 65 per cent. of carbonate of lime associated with argillaceous matter containing oxide of iron.

The Mulgrave cement made at Whitby from stone found on the east coast of Yorkshire, the Medina cement from the Isle of Wight, as well as various quick-setting cements made in different parts of the country, may be regarded as more or less partaking of the same character as the so-called Roman cement. The operation of burning these natural cement stones is a very simple one, but requires care and experience, the object sought to be attained being to drive off the carbonic acid from the carbonate of lime, and to cause the silica of the argillaceous portion of the stones to enter into combination with the lime, forming silicates that are capable of being readily attacked by hydrochloric acid. To effect this a very high temperature is not necessary, and should indeed be avoided, for many of these natural stones, if exposed to the same temperature as that which is employed in the manufacture of Portland cement, would undergo partial vitrification, and would no longer, when mixed with water, possess the setting properties of cement. The stone is burnt in a kiln worked on the intermittent system, and afterwards ground to powder, the quality of the cement depending upon a proper selection of the stone and the care taken in firing. The trade in Roman cement was at one time of so much importance that the question was raised whether foreign vessels should be allowed to dredge for the stone off the English coasts; but partly owing to increased supplies of material from which cement answering all the purposes of the original Roman can be prepared, but chiefly to its having been superseded by Portland cement for all purposes where strength and durability are required, the Roman cement manufacture has ceased to possess any especial interest. The cement known as Portland, which was so named from a fancied re-

semblance of blocks of this material to Portland stone, far exceeds in importance every other description of cement, both as regards the extent of the manufacture and the purposes to which it is applied. A patent was taken out for the manufacture of this material, in the year 1824, by Mr. Jos. Aspdin, a Yorkshire bricklayer, who states in his specification, that he mixes powdered limestone and argillaceous earth in a fine state of division with water, then evaporates the water, and calcines the mass in a furnace until the carbonic acid is entirely expelled, and this is essentially a description of what is done at the present time. This was not the first attempt at the artificial preparation of hydraulic cement, inasmuch as so far back as 1810, a patent was granted to Edgar Dobbs, for burning a mixture of lime, clay, or any earthy material, for the manufacture of cement, and in 1818 another patent was taken out by Maurice St. Leger, for the use of a mixture of chalk or lime with clay or any substance consisting of silica and alumina; this mixture was to be made into a paste with water, dried, and burnt in a kiln. For some time prior to Aspdin taking out his patent, the well-known French engineer, M. Vicat, had been engaged in carrying out a series of experiments on the subject of hydraulic limes and cements, and an investigation of the subject was also undertaken by General Sir Chas. Pasley in 1826, at Chatham, who, in the course of his experiments, was the first to make use of the Medway blue clay, which has since been the principal source of the supplies of silica and alumina required for the manufacture of Portland cement in the chalk districts. It is a curious fact that in the early attempts to prepare Portland cement from artificial mixtures of clay and chalk, great care was taken to avoid too high a temperature in the kiln, and the light-coloured underburnt pieces (such as are now returned back to the kiln to be more thoroughly calcined) were regarded as yielding the best cement. The first to establish works on the Thames for the manufacture of Portland cement was Mr. Frost, who, about the same time that General Pasley commenced his experiments, erected kilns at Swanscombe, which were subsequently transferred to Messrs. White Bros., who have since that time continued the manufacture. Some time afterwards a son of Mr. Aspdin established works in the same neighbourhood at Northfleet, a place that is now almost entirely devoted to the cement trade.

For some considerable time the quantity produced was very small, whilst the quality produced was variable, and could not be depended upon, and so little was the new cement appreciated, that in 1833, whilst Roman cement was selling at 1s. 6d. per bushel, only 1s. could be obtained for Portland. The trade has now become an important branch of national industry, every year new works are commenced, or old ones enlarged and supplied with new and improved machinery for saving labour, the demand for the article keeping pace with the increased supply. English makers are now so closely pressed, both as regards quality and price, by their German competitors, that it is only by exercising the greatest economy, and the production of the best quality, that they can hope to succeed in maintaining their position, The valuable qualities of this cement were early appreciated by the French engineers, and a large quantity of English-made cement was employed in the construction of the French docks and harbours.

The greater portion of the cement made in this country is manufactured at the numerous works situated on the Thames and the Medway, the materials from which it is prepared being simply chalk and clay. The upper chalk, or that in which flints most abound, is that which is employed on the Thames, the grey chalk which lies immediately below it being also used on the Medway.

The clay used for mixing with the chalk is obtained by dredging at low water on the banks of the Medway. Care must be taken in obtaining it that it is free from sand, and that it contains no fibrous vegetable matter; in the condition in which it reaches the works it contains about 40 per cent. of water. There is nothing very peculiar in the composition of this particular clay that should render its use essential for the manufacture of good Portland cement, the gault clay, as well as other descriptions of clay, being applicable for this purpose; any unctuous clay in which the proportion of alumina is considerable, that is free from sand and other impurities, and is capable of being reduced to a fine state of division, can be used for the manufacture of Portland cement. The clay and chalk in the proportion of three parts of the upper chalk or four parts of the grey chalk to one part of clay are thrown together, with a quantity of water, into a wash mill, which consists of a large circular trough (varying somewhat as regards character and size, but being gene-

rally about eighteen feet in diameter) in which the mixture is ground by means of a revolving beam to which heavy bars of iron are attached, to the condition of a fine semi-fluid mud, or "slurry" as it is termed. The slurry is then pumped up to be further ground, either between rollers or by horizontal stones, and passed thence to the drying floors.

Until within the last few years, a very much larger quantity of water was put into the wash mill than is now generally the case, the slurry being pumped up into reservoirs or "backs" (as they are termed), where it remains until the mixture of clay and chalk held in suspension by the water had deposited, when the supernatant water was drawn off, and the slurry, as soon as it had attained sufficient consistency, had to be wheeled away in barrows to the drying stoves. This system necessarily involves a great deal of manual labour, besides a considerable loss of time, several weeks being required to allow the particles of clay and chalk to subside; this method was, moreover, not conducive to the uniformity of the mixture, owing to the tendency of the heavier particles to deposit before those which are lighter. It is now the custom in most works to put only just enough water into the wash mill to make the slurry of a sufficiently liquid consistency to allow of its being removed by pumps. The drying of the slurry, instead of being conducted as formerly in special ovens heated by coke, is now carried out in chambers erected on a level with the top of the kiln, these chambers being heated by the waste gases from the kiln, as they pass on to the chimney. The kilns in which the cement is burnt are closed at the top, the products of combustion being carried through the chambers containing the slurry, so that, as soon as the turning of a batch of cement in the kiln has been completed, a further quantity of slurry is sufficiently dried for another charge, and as this is already on a level with the top of the kiln, the operation of filling the kiln is facilitated.

The kilns ordinarily employed for burning cement are somewhat similar in their construction to those used in burning lime, and are generally worked on the intermittent system, the difficulty experienced in working ordinary kilns continuously being quite as great in the case of cement as it is in burning lime. The Hoffmann kiln, which is largely used in Germany for cement, has not been adopted to any extent by English manufacturers; this may perhaps be partly accounted for by the fact that, in the chalk districts, the dry slurry is always, to some extent, in the condition of dry powder, whereas the materials for German cements are generally mixed dry, and moistened with water, and then made up into bricks before firing.

The object to be attained in burning cement is not merely to drive off the carbonic acid from the chalk, and to effect the transformation of the silica of the clay from an insoluble into a soluble condition, but also to bring about those combinations of silica, alumina and lime, which require a very high temperature for their production, giving rise to a hard, almost semi-vitrified clinker. So far from being injured by being exposed to a very high temperature (as is the case with natural cement stones), Portland cement cannot be manufactured of full strength without being subjected to such a temperature, although it must not be so great as to produce actual fusion, for under such circumstances the material would be useless for cement. The conversion of the silica of the clay into a soluble condition will be found to have taken place in the half-burnt, yellowish pieces of cement that are returned to the kiln to be re-heated, in which even some of the chalk is not calcined. The difference between a lightly-burnt cement and a well-burnt clinker would appear to be due to the action of alumina, and the part it plays in the formation of double silicates of alumina and lime, and aluminates of lime. It was shown by M. Frémy, many years ago, that aluminates of lime obtained by subjecting mixtures of pure alumina and lime (consisting of one equivalent of alumina with one, two or three equivalents of lime) to a very high temperature produce, when mixed with water, hydrated aluminates of lime, which not only possess the property of hardening under water, but are capable of binding together very large quantities of sand into a mass possessing the hardness of stone. In the lias districts in Warwickshire, the limestone (which is of a harder description than chalk), and the shales which take the place of mud, are passed through toothed rollers and ground to a fine powder by horizontal stones. The powder is mixed in a pugmill, with as much water as is necessary to form a soft paste of sufficient plasticity to be capable of being separated into pieces about the size of bricks, which, when dried, are ready for the kiln.

When drawn from the kiln, the calcined cement is crushed between rollers and ground

to a fine powder by horizontal stones of the same description as those used in flour mills. Since it is necessary, in order to obtain the strong cements now demanded, that the mixture of chalk and clay should be heated to such an extent as to bring it into the condition of a hard clinker, the question of its being sufficiently ground has become one of great importance, on account of the difficulty experienced in reducing such a hard material to a very fine state of division. Unless the cement be ground fine its binding properties cannot be developed, and the quantity of sand it will bear mixing with is diminished. The coarse particles of cement which will not pass through a 50-mesh sieve are totally inert as a binding material; they will not even adhere together, although they may be converted, by simply grinding to powder, into an excellent cement. There can be no doubt but that the finer a cement is ground, the better it is; it would, however, be manifestly impracticable to reduce a hard, well-burned clinker to an impalpable powder; the fineness must be limited by the cost of grinding. A few years ago a cement was thought to be sufficiently ground if 80 per cent. would pass through a 50-mesh sieve; now, however, it is required that 90 per cent. should pass a 76-mesh sieve, or 5,800 meshes to the square inch.

When ground, the cement is conveyed to a store (the results of several days' grinding being mixed together so as to insure as far as possible uniformity throughout the bulk), where it should remain for three weeks or a month before being issued. However well made a cement may be, yet if it be mixed with water too soon after grinding, heat is generated, and it is liable to swell and crack; hence the necessity of making up small blocks, and observing whether any rise of temperature takes place on the addition of water, and whether, subsequently, any cracks make their appearance. Cement, to set properly, requires an ample supply of water, and will sometimes, if applied to a very dry wall, not adhere to it properly from deficiency of water. It would appear that the benefit derived from immersion in water continues for a considerable period, judging from an experiment made with two briquettes of the same cement, one of which was kept three years in air, and the other in water. The one which had been kept in water gave the highest breaking strain, had a more crystalline fracture, and contained more water in chemical combination than the briquette that had been kept in air for the same period.

The great improvements that have been made in the manufacture of Portland cement within the last twenty-five years, owe their origin in a great measure to its having been employed in the construction of sewers for the metropolitan drainage, under the superintendence of Mr. Grant, who, with the view of obtaining the best possible article that could be manufactured, devised certain definite tests by which the quality of supplies could be controlled. The terms of his first specification were "that it should weigh 110 lbs. per striked bushel, and that briquettes made up with water having a minimum area of 2¼ square inches, after immersion in water for seven days, should not break under a tension of 400 lbs., equal to 177 lbs. on the square inch." Such a limit appears to be absurdly low, now that we are accustomed to cements which well bear a tension of from 400 to 450 lbs. on the square inch, and yet, some eminent cement manufacturers of that time gave it as their opinion that a strain of 133 lbs. on the square inch was as much as cement could be expected to stand. Although the seven day test with neat cement is still very generally adopted on account of the inconvenience which a further delay in ascertaining the quality of supplies would entail, it is admitted that with hard burnt slow setting cements, a period of twenty-eight days would allow of much more satisfactory results being obtained. Tests should also be made with a mixture of one part of cement and three parts of clean sharp sand; briquettes made of this mixture should be put in water twenty-four hours after they have been made, and at the expiration of twenty-eight days bear a strain of 250 lbs. on the square inch. It is important that the same description of sand should be employed in all cases, the particular kind of sand now very generally adopted is that obtained from Wortley Field sand-pits, near Leighton Buzzard. The grains of sand should also be of uniform size, and only those portions should be employed which have passed through a sieve of 900, and been retained by one of 1,600 meshes to the square inch. Inasmuch as the finer grinding of any cement makes its weight per bushel lighter, the actual specific gravity of the cement (which should be 3·1) is now regarded as a better criterion of its quality.

A new method of calcining cement has been proposed by Mr. Frederick Ransome, which yields very promising results. It consists in the use of a furnace composed of a revolving cylinder placed in an inclined position, and

lined with fire bricks or other refractory material in such a manner as to produce a number of parallel longitudinal ridges, or "feathers" through the entire length of the cylinder. The fuel employed is gas obtained from slack coal by means of an ordinary gas producer, the air necessary for its combustion passing through a regenerator heated by the waste heat from the revolving furnace. The slurry is lifted to a hopper placed at the upper end of the cylinder, from which it falls in a steady shower through the flame of the burning gases, which enter at the lower end of the cylinder. The slurry, as the cylinder revolves, is caught by the "feathers," and is lifted until the feather attains such an inclination as to shoot it off to the bottom again, but owing to the inclined position of the cylinder at every revolution, gradually nearer to the lower end; this occurs repeatedly, until the completely calcined cement falls into a receptacle at the lower end of the cylinder, which is rotated at such a speed as to allow about half-an-hour for the cement material to pass from one end of the cylinder to the other. It is obvious that such a method must possess several important advantages:—

1. The cement when it leaves the cylinder is in the condition of a coarse powder, some of the particles being about the size of beans, instead of being in heavy lumps of hard clinker; it is consequently capable of being easily ground to a fine powder, which is not the case with the ordinary cement clinker.

2. A very considerable saving of fuel is effected, the consumption being estimated at not more than one-third of that required in ordinary kilns.

3. The temperature is completely under control, and the cement is not exposed to a high temperature for a longer period than is necessary for perfect calcination, whilst every particle is subjected to the same amount of heat; the cement is consequently of a more uniform character.

4. The plant required is of a less expensive character than is necessary with ordinary or circular kilns, a cylinder of about four feet in diameter, and twenty feet in length, being regarded as capable of turning out as much cement as a thirty ton ordinary kiln.

The most important point to be determined in the analysis of Portland cement is the proportion of lime, which in a well-made cement should be from 58 to 62, or perhaps 63 per cent. Any excess of lime should always be regarded with suspicion, inasmuch as it is well known that by increasing the proportion of lime, the strength of briquettes made of such cement at the end of seven days may be augmented. An excessive amount of lime, however, cannot be employed without incurring the risk of the cement cracking and becoming disintegrated.

When the lime is associated with magnesia, the magnesia should be regarded as to some extent taking the place of the lime, and the quantity of the lime should be proportionally diminished. A well prepared Portland cement, such as is made on the Thames or the Medway, should not contain any appreciable quantity of magnesia, say about one per cent. Although any large proportion of magnesia in Portland cement cannot be considered desirable, yet it must not be forgotten that magnesia is capable of forming hydrates of great permanence and hardness, and that some very good hydraulic cements contain as much as 8 per cent. of magnesia, such, for example, as the well-known Rosendale cement of the United States of America.

There can be little doubt but that the assertions that have been frequently made as regards the tendency of cements containing magnesia to disintegrate may sometimes have arisen from overlooking the fact that the results observed might be due to excess of basic constituents in the cement. In a recent statement put forward as to the injurious action of magnesia, the cement referred to contained 72 per cent. of lime and magnesia, and it could scarcely be regarded as extraordinary that such a cement should prove a complete failure, since it is well known that such a proportion as 72 per cent. of lime would render any Portland cement so unsafe as to cause it to be condemned.*

One of the materials of which it has been attempted to make cement similar in its character to Portland, is blast furnace slag. Many endeavours have been made from time to time to utilise a material for which, until a few years ago, no application could be found except for road-making purposes. A great number of patents have been taken out with the view of accomplishing this object. In 1864 the plan of subjecting the melted slag (as it runs from

* From a recent report of Professor Brazier on the cause of the failure of some Portland cement used in the construction of a graving dock in Aberdeen Harbour, it would appear that the reaction which takes place between the magnesium chloride contained in sea water and lime may, under certain conditions, be sufficient to cause the disintegration of some descriptions of Portland cement, the lime in the cement being dissolved.

the furnace) to a powerful jet of air or steam, was proposed by Mr. Geo. Parry, which causes the slag to assume the appearance of wool. This slag wool can be used for a variety of purposes, and, being a bad conductor of heat, is well adapted for use as a covering for boilers steam-pipes.

When we recollect that this slag consists principally of silica, alumina, and lime, and that the silica is in a condition in which it is more readily capable of entering into new combinations than it is when in the form of clay, it might be expected that we have in blast furnace slag a material pecularly calculated to be of service in the manufacture of cement, artificial stone, or mortar. Accordingly we find that, as far back as thirty-seven years ago, attempts were made to utilise slag for such purposes. In 1850 a patent was secured by Mr. Jos. Gibbs for the manufacture of mortar and artificial stone by mixing ground slag with lime. The subject was subsequently taken up by some of the owners of ironworks, and a method for working slag was devised by Mr. Chas. Wood, of Middlesbrough, by the adoption of which he estimated that slag could be reduced to the condition of slag sand at a cost of a few pence per ton.

The molten slag is made to flow into a bath of water, which is kept in a state of violent agitation by a revolving cylinder provided with a series of perforated screens or buckets, by which the slag is separated into small particles and carried up into a spout, which conveys it into trucks placed to receive it, the water falling back into the bath through the perforated screens. Many thousands of tons of slag sand have been manufactured in this manner, from which mortar is prepared by grinding the slag with 5 per cent. of lime, the mortar setting so quickly that it is necessary to use it within twenty-four hours of its having been made. Bricks are also manufactured in vast quantities by mixing the slag sand with 10 per cent. of slaked lime, and pressing the mixture into bricks, which, when dry, are ready for use, without requiring to be subjected to the heat of a kiln.

Attempts have long been made to manufacture a cement resembling Portland from slag sand, but until recently without leading to any very successful result. If care be taken in selecting the slag sand, in ascertaining its composition, and in mixing with the proper proportion of chalk, very excellent cement may be produced, for the calcining of which Ransome's revolving cylinder is especially adapted. The slag-sand cement, prepared in a proper manner by what is called the homogenised cement process, as promoted by the Improved Cement Company, certainly gives results which are somewhat surprising, since *briquettes* made of this cement, whether tested neat at the end of seven days, or mixed with three parts of sand at the end of twenty-eight days, will stand the same tension test as good Portland cement. At the same time it must be borne in mind that great caution is necessary in adopting a cement of this nature, more especially when it is recollected that blast-furnace slags differ materially in their composition, and it is therefore not surprising that the introduction of a cement of this unusual character should have much to contend with as regards want of confidence in its power to retain its good properties for any length of time, more especially as previous experience on the subject of cement would tend to lead to the conclusion that no sufficient combination of the silica and alumina with the lime could be brought about by mechanical mixture alone, however intimately the substances might be incorporated with each other. It would appear, however, that when care is taken to see that the constituents of the cement exist in suitable proportions, a very serviceable article is capable of being produced. The cement is prepared by simply mixing together, in the most intimate manner possible, slag sand and dry well-slaked lime, without subjecting the mixture to any firing process. The secret of the success that has attended this method of making cement would seem to be the result of the very intimate mixture that is obtained by means of a revolving metal cylinder containing a number of iron balls, favoured by the soft and somewhat spongy character of the slag sand. In this, as well as in all new descriptions of cement, time is necessary to discover its defects or establish its merits. If a cement made in so simple a manner will continue to increase in strength for as long a time and to the same extent as Portland, this slag sand cement must become an important branch of manufacture; but at present its lasting qualities are not sufficiently established to allow of its being employed for any important work without the engineer incurring a little responsibility. It has, however, been clearly proved that a very excellent material, capable of being used as cement mortar, can be made out of slag sand by this method.

Some excitement has lately been created by

numerous letters which have appeared in the newspapers on the results produced by mixing sugar and lime together, for the manufacture of mortars and cements. Unfortunately, these communications have seldom given sufficient details of the nature of the experiments made to enable any one to say how far the results described are due to the sugar or to other causes. A mixture of sugar and pure lime made into a paste will set very hard upon the surface, but the interior of the mass remains in a friable condition, and will not withstand the action of water. Sugar may possibly be used with advantage where only pure lime is to be obtained, but it is not probable that any such mixture will compete in strength and durability with a good hydraulic lime.

Amongst the most recent novel applications of cement are those of Mr. Wilson, of Grays, Essex, who, by enclosing in the cement wire-netting and hoop-iron, so strengthens it as to enable him to construct cisterns and drain-pipes that will stand very rough treatment, without being inconveniently heavy. He also constructs telegraph poles, as well as a variety of other articles for which cement has hitherto been considered as unsuitable.

Plaster of Paris.

The setting of cements like Portland and Roman is due to combinations of a somewhat complicated character, the precise nature of which is far from being distinctly understood. It is altogether a different question with respect to plaster of Paris, which is due to hydration only. Gypsum is sulphate of lime combined with water, and when exposed to a temperature of about 360° Fahr. the water is driven off, and anhydrous sulphate of lime, known as plaster of Paris, remains. Sulphate of lime is found in nature in the form of transparent prisms, as selenite, and in opaque and semi-opaque masses, as alabaster and gypsum; it is also found not in combination with water, in which condition it is termed anhydrite. The principal beds of gypsum belong to the Tertiary system, the finest of these deposits being those of the Paris basin in the district of Montmartre. In this country it is found most abundantly in the counties of Derbyshire and Nottingham, extensive plaster works being carried on in the vale of Belvoir, a short distance from Newark, where the gypsum occurs in beds varying in thickness from a few inches to three or four feet. The only preparation which the gypsum undergoes previous to calcining consists in chipping off the outer portions, which, being contaminated with earthy matter, would injure the colour of the plaster. With all the varieties of gypsum there is a tendency to assume a crystalline character, and accordingly, as it possesses less or more of this structure, it is described as dense, granular, or fibrous. The white translucent alabaster which is used in statuary is a compact mass of crystalline grains, so soft as to be capable of being easily turned or cut. The altar piece in the chapel at Chatsworth is a fine example of alabaster work. Gypsum, when finely ground, is known in the colour trade as terra alba, and is used to a considerable extent in the manufacture of colours.

It is, however, in the form of plaster of Paris that sulphate of lime is of the greatest value in commerce and in the arts. For its production several methods of heating the gypsum are adopted, a flat kiln or oven being generally employed in this country. After raising the kiln to a temperature of a low red heat, the firing is discontinued, and it is charged with the lumps of gypsum, which, after about eighteen hours, has lost its water of hydration, and become converted into plaster of Paris. The kiln is sometimes worked continuously, and is heated by flues which are carried round the chamber in which the gypsum is placed; when this method is adopted, it is necessary that care should be taken that the temperature does not rise too high, and that the plaster is withdrawn as soon as the water has been expelled. Considerable experience is required in carrying out this process (which is simply one of dehydration) successfully, for although when the temperature is kept within proper limits the plaster possesses the power of re-absorbiug its water with avidity, yet this power is diminished if the gypsum be overheated. When subjected to a red heat for some time, the gypsum increases in density, and if this temperature be continued, it gradually assumes the character of natural anhydrite, which does not possess the properties of plaster of Paris. It is safer not to drive off the whole of the water rather than risk exposing the gypsum to too high a temperature, as the retention of a small portion of its water does not prevent the plaster from re-absorbing the water that has been driven off.

Although plaster of Paris does not chemically combine with more than one-fourth of its weight of water, yet it is capable of forming a much larger quantity into a solid mass, the

particles of gypsum being converted into a network of crystals enclosing mechanically the remainder of the water. The value of plaster depends upon this property of setting with a very large quantity of water, for if the plaster were not capable of being used in the condition of a thin paste, its value as a material for taking casts would be greatly diminished; the thin plaster, when poured into a mould, fills every cavity, and the slight expansion which takes place in the act of setting forces it into the finest lines of the mould. Sulphate of lime is soluble in water to the extent of one part in 400, the solubility being but little influenced by temperature. It is on account of this solubility in water that cements which consist in a great measure of plaster of Pasis are incapable of bearing exposure to the weather.

By mixing gypsum with a small quantity of certain salts, such as alum, borax, and sulphate of potash, it is rendered capable of bearing a higher temperature than ordinary gypsum, without injury, and the character of the plaster produced is altered; the mixture setting into a harder material or cement, of which we have examples in the cements known as Keen's Parian and Robinson's.

Miscellaneous.

SAVING LIFE AT SEA.

A Parliamentary paper has just been issued containing the report of the Select Committee on Saving Life at Sea. The committee consisted of the following members of Parliament:—Lord Charles Beresford (Chairman), the Lord Advocate, Sir Edward Birkbeck, Mr. Hoare, Mr. Howard Vincent, Mr. Donkin, Captain Price, Sir James Corry, Sir Charles Palmer, Viscount Kilcoursie, Mr. Bruce, Sir William Plowden, Mr. Menzies, Mr. Thomas Sutherland, Mr. Taylor, Mr. Richard Power, Mr. Thomas Gill. Mr. Gourley subsequently took the place of Lord Kilcoursie. The report, which is unanimous, is as follows:—

In compliance with the reference to the Committee on Saving Life at Sea, we have examined witnesses representing the Board of Trade, shipowners, shipbuilders, and seamen, and beg leave to submit the following report:—

The Committee are of opinion that the provisions of the existing Acts relating to the matters referred to them are inadequate, and are not suited to the requirements of the modern mercantile marine, and that these Acts ought now to be amended.

Your Committee think that ships should be classified more clearly than at present, and proper names or numbers should be assigned to the different classes according to the various duties which they have to perform, and the different conditions of weather which they would probably have to encounter in carrying out those various duties.

The Committee are of opinion that the boats and life-saving gear of cargo vessels ought to be subjected to official inspection.

With reference to boats, the evidence points out the necessity for having new regulations affecting them. The existing law does not compel any passenger ship over 1,500 tons to carry more than seven boats, while in cargo vessels the boats are often considerably over the number which could possibly be useful to the crew on an emergency. Your Committee think that the boats of all vessels of over 100 tons register should be inspected at certain stated intervals, be lowered into the water and examined as to whether they are watertight, and whether the falls, davits, and all gear connected with the boats are in a thoroughly trustworthy and efficient condition.

Your Committee are of opinion that rafts might be usefully employed in an emergency, and be especially valuable in moderate weather as a temporary means of flotation.

Your Committee consider that in ships carrying passengers all seats, chairs, stools, lockers, and other movable articles on the deck of such vessels suitable for flotation should be sufficiently buoyant to be capable of supporting one or more persons in an emergency.

The present regulation, by which only two life-buoys are required to be carried by any ship, seems most unsatisfactory. Your Committee consider that the proportion of life-buoys to be carried on deck should be regulated by the size of the ship and the nature of the service in which it is engaged. They also consider that the provision of sufficient life-belts or other similar life-preservers for those on board is advisable, and that these should be distributed in such a manner in the vessel as to be easily accessible, without crowding, and that the United States regulations on this matter are worthy of attention.

Your Committee find that many passenger ships could not, without great inconvenience, carry so many of the ordinary wooden boats at sea as would suffice to carry the whole of the passengers and crew with safety in bad weather. Under such circumstances the crew would not be sufficient to man so many boats, nor could they all be got into the water in sufficient time in the event of very rapid foundering. Having regard, however to the fact that accidents occur probably as often in moderate weather as in bad, and having regard also to the fact that the very cause of the accident frequently incapacitates many of the boats, and to the further fact that an insufficiency of boats undoubtedly tends to cause panic, we are of opinion that all sea-going passenger ships should be compelled by law to carry such boats and other life-saving apparatus as would

in the aggregate best provide for the safety of all on board in moderate weather.

Your Committee are of opinion that the description of boats and other life-saving apparatus which might be considered suitable to the various classes of vessels should be left to the decision of a committee *ad hoc* of the Board of Trade, to which your Committee hereafter refer.

The Committee have not found it practicable to examine and report on appliances for saving life at sea other than those hitherto commonly used for that purpose. They are, however, of opinion that if a committee were formed, such as they hereafter suggest, it might usefully inquire into many appliances other than those above reported on.

Your Committee reiterate their opinion that fresh legislation is essential. A Bill introduced this Session has been handed in by Mr. Howard Vincent, embodying some of the recommendations of your Committee.

In order that the various points raised should be dealt with in an efficient manner, without prejudice to owner, builder, or those who navigate, your Committee readily adopt the suggestion of Mr. Thomas Gray, that the President of the Board of Trade should appoint a committee whose duty it would be from time to time to frame rules on these subjects. These rules would require the sanction of the President of the Board of Trade, and would lie on the table, and be open to challenge in either House of Parliament for a certain period before acquiring the force of law. Such a committee might consist of fifteen members, of whom three should be nominated by shipowners, three by shipbuilders, three by persons practically acquainted with the navigation of vessels, three by recognised associations of seamen, and three by Lloyd's Register and kindred societies, the members to be paid such travelling expenses and other remuneration out of the mercantile marine fund as the Board of Trade may determine.

Though the question of construction was clearly not included in the reference to the Committee, still they think it only right to state, after having heard the evidence, that the proper placing of bulkheads, so as to enable the ship to keep afloat for some length of time after an accident has occurred, is most important for saving life at sea, and a thing upon which the full efficiency of life-saving appliances largely depends.

General Notes.

Brussels Exhibition of Science and Industry, 1888.—The Executive Committee of this Exhibition are offering prizes for designs for bills, diplomas, and medals, to be used by the Committee, also for designs for small buildings to be erected in the Exhibition gardens, and for a method of contructing and arranging the water-closets, &c., in the Exhibition. The Secretary of the Society of Arts has received a supply of the conditions for the various competitions, and these he will be happy to send to any person requiring further information.

Melbourne Exhibition, 1888.—The following have been appointed on the Royal Commission in this country, for promoting the Centennial Exhibition which it is proposed to hold in Melbourne in 1888:—President, his Royal Highness the Prince of Wales, K.G.; Vice-President and Chairman, the Earl of Rosebery. Commissioners: The Marquis of Hartington; the Earl of Carnarvon; the Earl of Onslow, K.C.M.G.; the Earl Granville, K.G.; the Earl of Kimberley, K.G.; the Earl of Dunraven, K.P.; Lord Brassey, K.C.B.; Lord Armstrong, C.B.; the Right Hon. Sir Henry Thurstan Holland, Bart., G.C.M.G., M.P.; The Right Hon. Edward Stanhope, M.P.; the Right Hon. Hugh Culling Eardley Childers, M.P.; the Right Hon. Sir John Rose, Bart., G.C.M.G.; Sir Reginald Hanson, Bart.; Sir Charles Tennant, Bart.; Sir Frederick Leighton, Bart.; Lieut.-General Sir Andrew Clark, R.E., G.C.M.G., C.B., C.I.E.; Sir Graham Berry, K.C.M.G.; Sir James Dromgole Linton; Mr. William Turner Thiselton Dyer, C.M.G.; Prof. John Robert Seeley; Mr. William Agnew.

Interlocking Railway Points and Signals.—There is now on exhibition in the Society's library a model of a method of locking and detecting points and signals for railways, the invention of Messrs. J. Hill and J. P. O'Donnell. Instead of the locking being effected only in the lever-frame of the signal-cabin, the principal interlocking is effected by an apparatus placed on the ground near the switch points themselves. The device by which the result is obtained consists of a sliding-frame (attached to the switch points) crossing a fixed frame bedded on the sleepers. Both frames have "uprights" (longitudinal bars) with channelled notches (or rising stocks) holding or guiding a set of three parallel sliding blades, which latter have counterpart notches or blocks occasioning the locking and detecting actions. The set of three parallel sliding blades, say A, B, and C, consist of a left-hand (A) blade working when drawn (say) the main-line signal, a right-hand (C) blade working similarly the branch-line signal, and the central blade (B) selecting and drawing either A or C, according as the sliding-frame moving with the switch points shall have at any time placed A within and C beyond (or *vice-versa*) engaging distance of B. A single cabin lever actuates B, and thus suffices to work *two signals*, the selected one of which is bound to be in agreement with the position in which the switch points are locked, the other signal being simultaneously locked at "danger." The principle thus briefly indicated is capable of being worked out to considerable elaboration. The model shows the arrangements of a main and branch line with facing points, four signals being provided, one "home" and one "distant" signal for the main, and another similar pair for the branch.

Journal of the Society of Arts.

No. 1,813. Vol. XXXV.

FRIDAY, AUGUST 19, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

"OWEN JONES" PRIZES, 1887.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon trust to expend the interest thereon in prizes to "Students of the School of Art who, in annual competition, produce the best design for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates for the present year:—

1. Gertrude M. Ginn, School of Art, Hertford.—Design for floor tiles.
2. Jane B. Glanvill, School of Art, Cavendish-street, Manchester.—Design for carpet; design for cotton print.
3. Robert H. Slowan, School of Art, Glasgow.—Design for printed hanging.
4. Fanny Roylance, School of Art, Cavendish-street, Manchester.—Design for printed cotton.
5. James West, School of Art, West London.—Design for wall-paper.
6. John Macfarlane, School of Art, Cavendish-street, Manchester.—Design for table cover.

The next award will be made in 1888, when six prizes will be offered for competition.

EXAMINATIONS, 1888.

The Programme for 1888 is now ready.

The subjects in which Examinations are held are as follows:—(1) Arithmetic; (2) English, including composition and correspondence, and *précis* writing; (3) Book-keeping; (4) Commercial Geography and History; (5) Short-hand; (6) French; (7) German; (8) Italian; (9) Spanish; (10) Political Economy; (11) Domestic Economy; (12) Theory of Music; (13) Practical Music.

The Examinations are held at all places in the United Kingdom where suitable Committees can be formed. A fee of 2s. 6d. is required from each candidate in each subject, except Practical Music, for which special fees are charged. 1st, 2nd, and 3rd class certificates are given in each subject. Full details of the conditions of the Examinations, together with syllabuses of the subjects, will be found in the Programme, which can be had gratis on application to the Secretary.

The Examinations will be held on the 9th, 10th, 11th, and 12th of April.

The Practical Examination in Vocal and Instrumental Music will be held in the Society's house during the week commencing on May 21st.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.
7. Hand-tooled Bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday,

3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered will be found in the number of the *Journal* for July 8th, and can be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

BUILDING MATERIALS.

By W. Y. Dent, F.C.S., F.I.C.

Lecture IV.—Delivered March 7th, 1887.

In my last lecture I directed your attention to Cements, some of which derive their binding properties from the formation of hydrated compounds of silica, alumina, and lime, and others from simple hydration, or combination with water only. There is, however, another cementing material in very common use, which is of an altogether different character, upon which I have a few remarks to make, commonly known as Asphalt, its value depending upon the binding properties of bitumen. Under the general term of bituminous substances are included a variety of inflammable materials found in nature, such as pitch, tar, asphaltum, naphtha, petroleum, differing from each other in consistency, and in various other respects, but all possessing a peculiar and characteristic odour; of these, naphtha is the most fluid, and asphalt the most compact and solid. The largest deposits of this character are those of the Dead Sea and the lake of Trinidad; this tar lake is more than a mile and a-half in circumference, and of unknown depth; the bitumen near the shore is solid, but decreases in consistency as it approaches the the centre, where the temperature is higher. Extensive bituminous deposits are also found in Auvergne and other places in France, at Seyssel near the Rhone, and elsewhere. The petroleum wells in America and Russia have probably had the same origin as bitumen. These bituminous deposits are supposed to have resulted from the action of heat and moisture on vegetable substances under pressure, the products of such action, which under ordinary circumstances would have been evolved as gas, having been compressed into a liquid or solid form. When bitumen is mixed with chalk, it forms a compact semi-elastic solid, which is not affected by alternations of temperature nor reduced to powder by attrition, and such a material is, on account of its plasticity and tenacity, as well as from its being impervious to water, particularly suitable for floors, pavements, and other purposes where it is liable to be exposed to a great amount of friction. No artificial mixture of bitumen and calcareous matter is so well adapted for the manufacture of the description of asphalt used for road-making purposes as the natural deposits found at Val de Travers and at Seyssel; its superiority being possibly due to the very perfect manner in which the carbonate of lime is incorporated with the bitumen, owing to the enormous pressure under which these deposits have probably been produced. The native asphalt rock consists for the most part of carbonate of lime, more or less impregnated with bitumen, the quantity of which varies from about 6 to 12 per cent.—that from Val de Travers, in the canton of Neuchatel, containing rather more bitumen than the Seyssel. The prepared asphalt, as sold by the makers, is termed "mastic," for the manufacture of which the asphalt rock is crushed under a steam hammer, and ground to powder by edge runners. The powdered rock is then carried forward by means of an endless screw to cast-iron vessels placed over a fire, in which it is mixed with suitable proportions of fine sand and bitumen, and kept constantly stirred for from two to three hours, when it is run out into blocks of 120 lbs. in weight. When the mastic is used, it is reheated with more bitumen, in order to render it sufficiently fluid, more or less coarse sand being mixed with it according to the purpose to which it is going to be applied. Coal-tar pitch is sometimes used instead of mineral bitumen, but this deteriorates the quality of the asphalt, coal-tar pitch being a hard brittle substance which does not possess the toughness of mineral bitumen; it softens readily when exposed to heat, and pavements made with such asphalt are liable to become soft and adhesive under the influence of a hot sun. Good asphalt should withstand a temperature of from 140° to 160° Fahr. without being affected to any appreciable extent, and should not become so fluid as to run down below a temperature of 260° Fahr.

Preservation of Wood.

The best means of preserving timber from decay, and enabling it to resist for the longest possible period those changes that are included under the term eremacausis—which may be regarded as a species of slow combustion of the constituents of the wood with the oxygen of the atmosphere—is a subject that has for many years occupied the attention of chemists and engineers.

Wood consists of a mass of cells or fibres, the newer portions of which are filled with the particular kind of sap appertaining to each special description, which, when the life of the plant ceases, can no longer resist the influence of the surrounding air and moisture, but begins to be subjected to a process of oxidation as the air gains access to the juices of the sap through the tissues of the wood. These juices consequently begin to ferment and decompose, the albuminous constituents, or those containing nitrogen, being the first to undergo this change, which proceeds from these to the mucilaginous, such as sugar, starch, and gum. This fermentation is assisted by the moisture contained in the wood, and is attended with the appearance of fungoid growth, when it is generally known by the term "dry rot." This dry-rot fungus possesses the property of secreting moisture, even from a moderately dry atmosphere, and hence, when once the growth of this fungus commences, it proceeds with rapidity, since it is able to procure for itself the moisture that is essentially necessary for its increase. Unseasoned wood contains within itself the elements of decay, and affords the conditions necessary for the development of the dry-rot fungus. When such wood is placed in situations where there is not a free circulation of air, this fungoid growth soon makes its appearance, and the germs spread rapidly in every direction, the wood becoming in a comparatively short time reduced to the condition of fine dust.

When wood is thoroughly seasoned, external moisture is necessary for the commencement of this process of decay; but perfectly dry wood shows but little tendency to alteration, as we find to be the case with the gopher wood found in Egyytian catacombs. Timber of slow growth is less liable to decay than when it arrives quickly at maturity, this being the case even in timber of the same description. It has been stated that telegraph poles made from trees grown in the comparatively rich soil of Devonshire begin to decay in a shorter time than poles made from the larches grown in the Highlands.

When timber is immersed in water containing air in solution, and the air is constantly being renewed, the woody fibre will in course of time be converted into a dark brown substance, to which the name of *humus* has been given, this being one of the constituents of vegetable mould.

It is well known that the decay of wood under such circumstances is rapid, as is the case in tidal rivers, or in other situations in which the wood is alternately exposed to the action of air and water, as compared with wood immersed in deep water, or in still water that is not changed. The air contained in such water becomes exhausted of its oxygen, and the process of decay is arrested, or may never take place to any extent. Accordingly, it is found that piles driven in deep water, or in clay or mud, will remain sound for an almost indefinite length of time, as was exemplified in the elm piles of old London-bridge which, when taken up, were found to be in a sound condition after the lapse of 800 years. Only a few years ago two canoes, each formed from a single log of oak, were recovered in good condition from the bottom of a loch in Aberdeenshire, where they are supposed to have been lying for 1,000 years. More recently, a boat, similar in character to these canoes, was discovered at Brigg, in Lincolnshire; and in 1881, in making excavations for steam docks at Liverpool, a portion of a ship was found which must have been embedded for at least 200 years, the elm beams of which were in a perfectly sound condition. Besides being liable to gradual decomposition by the ordinary and natural processes of decay, timber is liable to be injured by the attacks of boring worms, the most formidable of which are the *Teredo navalis* and the *Limnoria terebrans*, and also in hot climates by that very destructive insect, the white ant. The capabilities possessed by different kinds of wood of resisting these attacks vary considerably. Those descriptions which contain a large amount of resinous matter, such as the greenheart timber of Demerara, and pitch pine, *Pinus rigida*, are less liable to such attacks than much harder woods which are of a less inflammable character. The greenheart timber contains so much empyreumatic oil that it is known by the name of torchwood, on account of its burning freely like pitch pine, and there is no

doubt that it is from the presence of this oil that it derives the power which it possesses of resisting these attacks to a greater extent than most other descriptions of wood. There are other woods that are reputed to have similar capabilities of resistance, of which there were a number of very fine specimens in the Colonial Exhibition. Amongst these may be mentioned the billian, a hard very dense wood, and the russak wood from North Borneo; the cypress pine from Queensland; sneezewood from the Cape of Good Hope; horseflesh mahogany from the West Indies; the karri (*Eucalyptus diversicolor*), growing sometimes to the height of 300 feet, and the jarrah (*Eucalyptus marginata*), of which there was a beautifully polished specimen in the Exhibition from Western Australia. This wood was used for a portion of a jetty at Perth, on the Swan River, Western Australia, and remained perfectly sound after the lapse of thirty years.

Greenheart timber was for a long time considered to be safe from the attacks of boring worms, but the experiments carried out some time ago by the Dutch Government with this as well as other descriptions of wood, show that none of these woods can be thoroughly depended upon when placed in situations most favourable to the increase of these destructive agents. The extension of the railway system gave rise to the employment of an immense number of wooden sleepers, and the rapidity with which they were found to decay rendered some means of preserving them an absolute necessity, and accordingly we find that various methods have from time to time been proposed for the preservation of timber, some of which have been carried out in practice with more or less successful results. The efficacy of any such process depends upon the power of the material employed to so change the sap as to render it not susceptible of putrefaction, while it imparts to the wood such properties as will be unfavourable to fungoid growth, and will render it to a considerable extent repellent of water. The first process to receive any extensive practical application was that known as kyanising, which was the subject of patents taken out in 1832 and 1836 by Mr. Kyan, and consisted in steeping the wood in open tanks in a solution of bichloride of mercury, commonly known as corrosive sublimate. The impregnation of wood with a salt which is known to be so fatal to animal life could scarcely fail to prove effective; and this process was for many years very generally adopted. The cost was considerable, as to render the process efficient it was necessary to employ a solution containing 1 lb. of the mercury salt to 4 gallons of water and a load of timber was found to absorb as much as from 6 lbs. to 7 lbs. of the salt. This process has for many years been to a great extent superseded by others of a less expensive as well as more effective character, since although the use of corrosive sublimate was perfectly successful in dry situations, it did not always prove so satisfactory when the wood was subjected to the action of sea water.

Chloride of zinc is a salt which has long been known to possess considerable antiseptic properties, and in 1838 a patent was taken out by Sir Wm. Burnett for the use of this salt as a preservative of wood. In carrying out his process, he adopted the apparatus first proposed by M. Bréant in 1831. The wood was placed in closed iron cylinders into which, after exhausting the air, a solution of zinc chloride was admitted, and then forced into the pores of the wood under a pressure of 150 lbs. to the square inch. This process was employed on a considerable scale for many years, but it has now given place to more efficient methods, although it is still used to some extent in Germany.

Some years ago, a number of experiments were carried out by Dr. Boucherie, who very ingeniously availed himself of the force of the ascending sap in growing trees, by causing it to draw up various solutions. A large incision was made in the lower part of the tree, round which a trough of clay was placed, filled with the preservative solution to be tried, and this was carried up with the ascending sap. When experiments were made with felled timber, the trunk was immersed in a closed vessel which was filled from a reservoir placed at a considerable height above, so as to obtain a pressure of 30 or 40 feet, and in this manner Dr. Boucherie succeeded in replacing the sap of the timber by solutions possessing properties which were likely to preserve the wood. Of the various salts experimented with, copper sulphate gave the best results. This method of applying the solution was adopted for a short time in France; it possesses the advantage of requiring no machinery, and of being capable of application upon the spot, and hence it has sometimes been found useful for newly cut wood required for telegraph poles. The peculiar action which copper salts exert upon cellulose had long been known, and in 1837, a patent was taken

out by Margary for the use of sulphate of copper as a preserving agent for timber. This salt was extensively employed for many years, the impregnation of the wood being accomplished by the use of exhaust and force pumps, and it subsequently became the process most generally adopted in France. The effect of copper salts in the preservation of vegetable fibres from decay is strikingly illustrated in the case of what is known as the Willesden canvas. Fabrics of canvas or paper can be made perfectly waterproof by the action of a solution of the copper salt employed in the Willesden process, they are free from liability to mould, are not injured by wet, and are rendered capable of resisting the attacks of vermin of every description. This canvas has been used in the most trying climates, such as Egypt and India, and was employed by Stanley in fitting out his expedition to Africa. The copper solution employed is prepared by simply dissolving hydrated oxide of copper in strong liquid ammonia. The goods to be subjected to this process are passed through a bath of this solution, at such a rate as to cause the exterior portion of the fibres of the canvas or paper to become pectised or gelatinised, without allowing sufficient time for the action of the copper salt to proceed so far as to injure the strength of the material; the canvas is then passed over drums, such as are used in ordinary paper-mills, and dried, whereby the film of pectised cellulose is converted into an insoluble varnish. The paper or canvas can be made of any required thickness by passing two or more at the same time through the bath, pressing them together, and then drying, thus producing a material of sufficient strength for the purposes of light roofing.

By far the most important of all the methods now employed for the preservation of timber, and adopted almost to the exclusion of all others in England, Belgium, and Holland, is that known by the name of creosoting, which consists in impregnating wood with an oily liquid termed "dead oil," or heavy oil of tar, obtained in the distillation of gas-tar.

The efficacy of pitch, tar, and bituminous substances generally, as preservatives from decay, has been recognised from a very remote period, as we learn from the historical records of the Egyptians, Greeks, and Romans. The Egyptians undoubtedly displayed very great skill in the manner in which they conducted their processes of embalming. Bitumen, in one form or other, appears to have been largely employed, and their success could hardly be more strikingly exhibited than in the case of the heart of an Egyptian mummy which, after having been preserved for some 3,000 years, began to decompose upon the removal of the antiseptics employed. In the writings of Herodotus and Pliny we find a description given of pitch, tar, and resin, and from the latter celebrated writer we learn that the Romans were acquainted with the fact that timber was less likely to decay when kept continuously under water than when exposed alternately to the action of air and water, and also that they knew something of the destructive powers of the teredo.

The application of tar distillates to the special purpose of the preservation of wood was proposed as far back as 1754, when a patent was taken out for a varnish prepared from the American pitch pine, and for a product obtained from the distillation of tar to be applied as a preventative of decay in wood. In 1838, and again in 1848, patents were taken out by Mr. Bethell for the use of tar liquor.

There is perhaps no practical application of chemical science to manufacturing operations that has yielded such splendid results as have attended the investigation into the nature and composition of coal tar. Fifty years ago, no one would have ventured to surmise that in what was then regarded as an almost valueless, dirty, and evil-smelling waste product, obtained in the purification of gas, would be found the source from which would be produced a most splendid series of organic products that would not only rival the colours obtained from indigo and madder, but in many cases supersede them altogether, and create an entire revolution in the whole system of dyeing.

In distilling coal tar on a manufacturing scale, it is placed in a large iron still capable of holding about 2,500 gallons, heated by a furnace underneath, sometimes assisted by the injection of steam, and the application of an exhaust air-pump. As the still becomes heated, a light naphtha distils over between about 170° and 320° Fahr., which is of great commercial importance, inasmuch as it contains benzole or benzene, from which is obtained aniline, the basis of a series of colours, such as mauve and magenta. Between the temperatures of 320° and 370° Fahr. is distilled the liquid known as coal-tar naphtha, which is used so extensively for burning in lamps, and as a solvent for india-rubber. The liquor used for creosoting timber, termed "dead oil," or heavy oil of tar, from its being

heavier than water, distils over between 370° and 750° Fahr.; the residuum in the still is run out whilst hot, becomes perfectly solid on cooling, and constitutes the substance known as coal-tar pitch. This dead oil, or creosoting liquor, is of a very complicated character, consisting of a variety of hydrocarbons of different degrees of volatility, and possessing by no means the same antiseptic properties, the relative value of which, in this respect, it is difficult to estimate with any degree of accuracy. In the lighter portions are found carbolic and cresylic acids, substances which have long been known as possessing very great disinfecting properties, so much so, that for a long time they were regarded as the active agents upon which the value of the creosoting liquor (as a preservative agent for wood) depended. Within the last few years, however, the opinions of chemists have undergone considerable modifications in this respect, and there appear to be sufficient grounds for believing that the relative value of creosoting liquors is not represented by the per-centage of these acids which they may contain, since, owing to their volatility, they are not retained by the wood for so long a time as some of the other constituents. In the heavier portions of the liquor, or "green oil" as it is termed, distilling over between 550° and 750° Fahr., are found a number of alkaloids, or bases, amongst which is a powerful germicide of a very pungent and acrid character, termed "acridine," which having a very much higher boiling point than that of carbolic or cresylic acids, is more permanently retained by the wood. The minute glistening scales generally observable on recently creosoted wood, consist of naphthalene, a substance that possesses considerable antiseptic properties; when this substance exists in the liquor in moderate quantities, it thickens and improves its consistency; but when there is a very large proportion, as is frequently the case with creosoting liquor obtained by the distillation of coal tar produced at gas factories in which Newcastle coal is employed, it makes the liquor too solid. To be of proper consistency the liquor should be completely fluid at 100° Fahr., and should exhibit no signs of any deposit on cooling down to a temperature of 90° Fahr.

There are two classes of creosoting oil, known in the trade as London oils and country oils. The London oils, which consist of those obtained from the gas-tar derived from Newcastle coal, contain a larger proportion of naphthalene, and are heavier and thicker than the country oils of the Midland districts, which yield a larger proportion of tar acids (as they are termed), consisting of a distillate which is capable of being dissolved by a solution of caustic soda containing 9 per cent. of the alkali. Previous to the year 1863, only a comparatively small quantity of these thin country oils had been used for creosoting purposes, but they subsequently became more in demand, under the impression that the value of the oils depended upon the proportion of tar acids they contained. This question was investigated in 1866 by Mr. Coisne, an engineer in the service of the Belgian Government, whose experiments were continued during a period of five years, and the results obtained led him to the conclusion that the so-called green oils, distilling over at high temperatures, formed the best portions of the creosoting liquor, and that the importance of the tar acids had been much overrated.

In carrying out the creosoting process on a large scale, the dried wood (cut up into the sizes in which it is going to be used) is placed upon iron trucks, which are run on a tramway into large air-tight cylinders 6 feet in diameter, and from 20 feet to 70 feet in length, heated by steam-pipes placed along the bottom. When the trucks have been run into the cylinder, the end is closed, steam is admitted to the heating pipes, and an exhaust-pump is put in action which is capable of creating a vacuum of 25 inches. When this has been attained, the creosoting liquor is admitted from a reservoir, in which it has been kept at a temperature of 120° Fahr., by means of steam-pipes. A force-pump is now put in action, by which a pressure of 150 lbs. on the square inch is maintained for a period of from 6 to 10 hours, the temperature of 120° Fahr. being also kept up by means of the steam-pipes; the amount of pressure given, and the length of time that the steeping is continued, depends upon the description of wood to be treated, and the quantity of creosote that is required to be absorbed. When cost is no object, the penetration of the liquor as regards some descriptions of wood which absorb the most readily, such as beech and deal, is capable of being extended to a depth of 10 inches, but, as the process is usually carried out, the penetration does not extend further than from half-an-inch to 4 inches. The progress of the absorption of the liquor by the wood is ascertained by observing the quantity left in the reservoir, which is registered by a gauge, the amount usually required being about one gallon to a

cubic foot of timber of the sizes employed as railway sleepers. When the wood has absorbed this quantity, the pressure is removed, the liquor remaining in the cylinders is run off, the end is opened, and the trucks with their loads of creosoted wood are withdrawn. I have stated that in carrying out the creosoting process, as above described, it is necessary that the timber should be dry. Now it is well-known that timber is injured by exposure to a dry heat, 230° Fahr. being the extreme limit to which it can be exposed without liability to injury, and all attempts that have been made to effect the drying by stoves, currents of hot air, or superheated steam, have had to be abandoned; but by a modification of the creosoting process patented by Mr. Boulton, the moisture can be removed at the commencement. For this purpose a dome is fitted to the top of the cylinder, the liquor is admitted at a temperature only slightly exceeding 212° Fahr., and the action of the exhaust pump is continued for some time after the admission of the liquor.

It will seen that the wood is thus subjected to a moist heat above the boiling point of water, by which the water in the pores of the wood is converted into vapour and drawn off by the action of the suction-pump, the creosoting liquor taking the place of the water withdrawn from the wood. When the creosoting process has been properly carried out, the wood will be found to have increased in weight to the extent of from 8lbs. to 10lbs. per cubic foot, and to have been rendered so secure against the attacks of the marine boring worm, that a piece of timber has been known to have been riddled by such attacks in places where the liquor has not reached, and to be untouched where it had been properly impregnated with the creosoting liquor. This tar liquor not only possesses those antiseptic properties by which fermentation and the growth of insect life is arrested, as well as the power of coagulating the albumen of the sap in the same manner as is the case with copper sulphate or corrosive sublimate, but it also possesses the additional advantage of impregnating the wood with a liquid of an oily nature which is repellent of water. The efficacy of this process, and its superiority to all others that have been yet tried, is supported by the results of numerous experiments that have been made with great exactitude and care, both in this country and abroad, by engineers and others. There is no country so deeply interested in the protection of timber as Holland, on account of its having such a large extent of coast protected from encroachments of the sea by dykes that are constructed of timber. On several occasions fears have been entertained of large portions of the country becoming submerged owing to the destruction of the timber dykes by the ravages of the teredo, which works with such rapidity that in some instance piles have been known to have been eaten away to a dangerous extent in the course of a few months. The question of the preservation of their timber piles became one of national importance to the Dutch Government, and a commission was appointed, consisting of engineers and members of the Royal Academy of Amsterdam, to institute a thorough investigation of the subject. The experiments carried out by the commission were divided into three groups:—

1. Applications to the surface of the wood: which included carbonising or charring the wood, by subjecting it to a high temperature; treatment with paraffin; covering with sheet copper or zinc; covering with broad flat-headed iron nails, driven in close together and allowed to rust.

2. Impregnation with different liquids, including solutions of sulphate of copper, sulphate of iron, acetate of lead, water glass, chloride of calcium, and creosoting.

3. Different kinds of unprepared wood.

The conclusions that they arrived at were—That the only reliable process for protecting wood from the attack of the teredo was that of creosoting, and that even this fails if the process has not been properly carried out; that no kind of unprepared wood (greenheart included) is to be altogether relied upon as secure against the attacks of the teredo.

The descriptions of wood used in the construction of the dykes are fir, beech, and poplar. Some time ago twelve piles of each of these woods were sent over to this country to be creosoted, these were returned to Amsterdam, and placed in positions where improperly creosoted wood had previously been destroyed, and in no instance were any of the twelve piles attacked by the teredo. Some years ago experiments were made at Plymouth with different kinds of wood, consisting of red and yellow pine, American and English oak, elm, beech, fir, and pitch pine, which, after being dried in an open shed, were subjected to the following processes, viz., creosoting (one gallon of the liquor per cubic foot being forced into the wood), kyanising, and the sulphate of copper process. Blocks

of each kind of wood, after being subjected to the several processes, as well as others without any preparation, were sunk in still water to the depth of 20 feet, and, after remaining for $2\frac{1}{2}$ years, were taken up and examined. All the creosoted pieces were found to be sound, and all the unprepared pieces were worm-eaten. Of the kyanised, five were sound, and three slightly attacked; and of those prepared by the sulphate of copper, only one was sound. The increased use of creosote is shown in a report of July, 1884, to the Technical Convention of the German Railway Union, in which it is stated that in 1865 there were fifteen railway companies in Germany employing the sulphate of copper process, and only four the method known as creosoting; but that in 1884 there was only one using the sulphate of copper process, whilst eleven had adopted that of creosoting.

We have now had nearly fifty years' experience as regards creosoted timber. Wood so prepared was employed in the construction of dock gates at Monk Wearmouth as far back as the year 1839; creosoted wood was also employed on a considerable scale, in 1846, at Lowestoft. The evidence that can be produced of the value of this process as a means of preserving wood so far exceeds anything that has been advanced on the part of any other, that its claim to be regarded as superior to all other processes at present known, and as that upon which the greatest reliance can be placed, may be considered as fairly established.

The teredo is a grey-coloured worm, ordinarily, when full grown, about 10 in. or 12 in. in length, but in favourable situations (such as the Gulf of Mexico) it will sometimes attain a length of 23 inches. It is a species of mollusc, having at one extremity a boring apparatus of the most perfect description, consisting of a hard, shelly-like substance, which fulfils the part of an auger and a rasp. The teredo first makes its appearance in the form of a very minute egg; the eggs are laid at the commencement of the warm season, and are hatched in the water, giving out larvæ so small as to escape notice of the inexperienced observer, being not more than about 1-25th of an inch in length. After swimming about for a day or two, they begin to search for timber, which they enter by boring a very minute hole not larger than a pin's point; it is therefore of the greatest importance that no portion of the surface of the wood should be left unprotected by the preserving agent employed, and hence arises the necessity for cutting up the wood into the sizes in which it is to be used before submitting it to the creosoting process. The teredo grows rapidly under favourable circumstances, enlarging its hole as it increases in size. Its smaller end (consisting of two tubes) is attached to the end of its burrow, whilst its other extremity, armed with the auger, is pushed forward into the wood, the length of the tunnel corresponding with that of the teredo. As it progresses, it deposits a coating of carbonate of lime upon the sides of its cell, in which it continues to increase for from twelve to eighteen months, and then dies, after blocking up the entrance to its burrow with carbonate of lime. This stopping is soon penetrated by the water, which washes out the lining, leaving a smooth clean hole to bear witness to the destructive habits of this dangerous enemy to wooden structures. The teredo perforates in the direction of the grain of the wood as far as possible, but on meeting with a knot or anything which it regards as obnoxious, it avoids the obstacle by working round it, or it will work back and begin a branch tunnel, taking care to seal up the abandoned portion of its cell with carbonate of lime. It is a curious fact that although there may be hundreds of these worms in the same piece of timber, they never break into a neighbour's tunnel, although they will cut away within a hair's breadth of each other, or of the outside of the timber. A division, however thin, is always left ntact. The teredines thrive best in salt water and in warm climates, muddy fresh water being destructive to them.

Painting.

The method ordinarily adopted for preserving wood is that of painting, and in order to secure the attainment of this object, it is necessary that the material used for the solid portion or pigment should consist of some substance which can be obtained in a very fine state of division, and which is but little liable to change by long exposure to the weather. Various metallic oxides, such as the oxides of lead and zinc and the higher oxides of iron, fulfil these requirements, and we consequently find that these substances enter largely into the composition of paints. By far the most important of all the substances employed as pigments is that which is known by the name of whitelead, which varies in its character according to the process adopted in its manufacture. In spite of the very numerous alleged improvements

that have been announced within the last thirty years as having been made in the manufacture of whitelead, the largest portion of the best whitelead is still manufactured by the old "Dutch" process, as it is termed, from its having been introduced into this country from Holland. This process depends upon the corrosion of metallic lead; it is well known that when lead is exposed to moist air, the surface of the lead is corroded, that is, it is converted into a white substance which consists of carbonate and oxide of lead. The purest metallic lead is most susceptible of this change, and it is partly on this account, and partly because the whitelead produced from the purest lead is of a better colour, that manufacturers of whitelead are always anxious to obtain the best brands of metallic lead in the market. Nearly all lead contains traces of copper and silver, and very small quantities of these impurities affect the quality of the whitelead so much so that, when silver is present, even to so slight an extent as 1½ ozs. in a ton of lead, it imparts a distinct pink colour to the whitelead. In carrying out the manufacture by the Dutch process, the lead is first cast into gratings or crates by pouring the melted lead into an iron frame with longitudinal and transverse grooves into which the lead runs. This is done by machinery, the iron moulds are fixed on to an endless chain, and are being continually filled by a small stream of melted lead flowing from an orifice which can be opened or closed at pleasure, so as to regulate the flow of the metal. As the chain moves round, the crates of lead, when they have become solid, are thrown out, and are taken away to be placed in the corroding pots. The object in casting the lead in this form is to promote a freer circulation for the corroding vapours, and a larger amount of surface of metal to be acted upon than would be the case if the lead were cast in solid thick pieces. The corrosion is effected by exposure to the combined action of the vapour of acetic acid, carbonic acid, and moisture. The pots in which the lead is placed are made of earthenware, and have a shoulder in the interior about one-third of the height of the pot, upon which the coiled crate of lead rests. The pots are stacked in large beds of spent tan, which is spread evenly over the floor to the depth of 2 feet or 3 feet, upon which the pots are arranged in rows. Into each of the pots is put about one pint of acetic acid of about the strength of ordinary vinegar, which fills the pot up to the shoulder upon which the crate of lead rests. Tan is then placed around the pots to a level with the top, and a floor of loose boards is laid across the whole, this flooring is again covered with tan to the depth of 12 inches, a second series of pots, tan, and boards follow, which are succeeded by others, the stack being completed by a layer of tan from 24 inches to 30 inches in thickness. These stacks are of very large dimensions, often containing as many as from 6,000 to 10,000 pots, turning out from 30 tons to 40 tons of whitelead. Ventilating shafts are left in various parts of the stack for promoting the circulation of the corroding vapours through the several rows of pots, and for the escape of moisture. In the course of six or seven days after the completion of the stack, the tan begins to ferment and become hot, which promotes the rapid corrosion of the lead. The process is completed in about twelve weeks, and the stack is then taken to pieces. The temperature is regulated, as far as practicable, by covering or uncovering the ventilating shafts, but it is difficult to secure a uniform temperature throughout the whole of the stack. It will sometimes rise in the centre to 180° or 190°, which causes the acetic acid to evaporate too rapidly without a corresponding increase in the corrosion being effected, whilst at the exterior portions of the stack the temperature is sometimes not high enough, which is also detrimental to the quality of the whitelead produced; the best results being obtained when the temperature ranges from 150° to 160° F. It will be seen that the lead in this process is placed under the most favourable conditions for corrosion, being exposed to the action of acid fumes assisted by heat and moisture. On breaking up the stack and removing the upper layer of tan, as well as the boards which covered the pots, the lead is found to have become thickly incrusted with whitelead, only a thin core of metallic lead remaining. If the process has been properly carried out, no acetic acid is left, it having been dissipated by the heat generated during the fermentation of the tan, The separation of the whitelead from the metallic lead, or blue lead, as it is called, which remains, is effected by placing the corroded lead in a covered hopper, where it meets with a stream of water, and falls into a trough in which it is knocked about with wooden rakes. The whitelead, which is easily detached from the lead core which has not been acted upon, is then conveyed to a series of grindstones, by which it is reduced to a very fine state of division, and is carried

off suspended in water to tanks, in which it is allowed to deposit. The clean water is syphoned off, and the paste of whitelead is placed in bags and subjected to hydraulic pressure (by which the greater part of the water is squeezed out), dried, and ground.

The grinding is conducted in a mill so enclosed as to prevent the escape of dust. The reaction which takes place in the production of whitelead by this process, consists in the formation of a basic acetate, which is subsequently decomposed by the carbonic acid generated by the fermented tan, the final result being (when the process has been carried out in the most perfect manner) the production of a basic carbonate consisting of two equivalents of carbonate of lead and one of hydrated oxide. The process is a slow one, involving a great amount of labour; moreover, the arrangements for accomplishing a very simple operation appear clumsy and unscientific; many attempts have consequently been made at different times to supersede it by others of a more rapid and economical character. These attempts, however, although they appeared to be full of promise, have not hitherto been attended with that success that had been anticipated by their originators. It was very naturally supposed that a similar result would be produced by exposing sheets of lead in a closed chamber to the joint action of air, carbonic acid, vapour of water and acetic acid, and various attempts have been made on this basis. The method proposed by the celebrated French chemist, Thénard, consisted in passing carbonic acid through a solution of the basic acetate of lead, and whitelead thus made was for some time sold under the name of Clichy white. Numerous patents have since been taken out for the manufacture of whitelead upon the same principle, but differing in detail. Martin's process consisted in exposing metallic lead in the condition of thin scales (obtained by causing the melted lead to fall upon a revolving copper cylinder kept cool by a current of water) upon a series of racks placed over each other, through which a solution of acetate of lead trickled. The basic acetate thus formed being subsequently decomposed by carbonic acid, the carbonate of lead thus obtained was then mixed with lead oxide prepared by exposing granulated lead in a barrel perforated so as to admit air, and caused to revolve in a trough containing a little water, which washed off the oxide as it was formed. It was found, however, that the product obtained by the precipitation of a salt of lead from solution, even when so manufactured as to possess precisely the same composition as that made by the Dutch process, is more or less crystalline in its character, and does not possess that density upon which the excellency of the whitelead produced by corrosion depends, which is known in the trade by the term ' body." The chief objection to the Dutch process is the fact that it cannot be carried out without injury to the health of those engaged in the manufacture, owing to the absorption of lead into the system, partly from the floating particles in the air, and partly through the pores of the skin from handling the whitelead during the several processes it undergoes. The workpeople are consequently liable to attacks of painter's colic, a disease which produces pains in the limbs, a characteristic blue discoloration of the gums, and sometimes partial paralysis. The evils arising from this cause have, however, in all well-regulated works, been greatly diminished, by taking care that. as far as possible, the various operations of scaling, &c., should be carried on in water, by providing respirators for those exposed to the dusty particles, and gloves for those who have to handle the whitelead, and by enforcing the strictest regulations as to cleanliness. The assertion is often made that persons may be affected with lead poisoning by the vapours arising from a newly-painted wall, but such assertions are not supported by any sufficient evidence. Experiments that have been carefully made show that no lead in any form or shape either evaporates or is carried off mechanically during the drying of the paint. The fact is, that the vapours arising from the oil and turpentine affect some people to such an extent as to make them seriously ill, and the effects produced by fresh paint would be the same whether the pigment employed consisted of whitelead or zinc oxide. Whitelead, as ordinarily used, is mixed to a large extent with sulphate of baryta, a substance which, on account of its high specific gravity, is in much request as an adulterant.

Amongst the most recent substitutes for whitelead as made by the Dutch process, is the so-called "non-poisonous whitelead" of Messrs. Freeman, which is prepared by grinding under considerable pressure a precipitated sulphate of lead with 25 per cent. of zinc oxide, whereby the density of the mixture is greatly increased. This preparation possesses

the advantage of a very simple and unobjectionable method of manufacture, and of keeping its colour better than ordinary whitelead when employed in situations in which it is exposed to air containing sulphur compounds, such as in railway tunnels. It is equal to the ordinary white lead in point of colour, and is reported to be so as regards "body" and durability, but this last point can only be decided after the lapse of sufficient time.

For situations in which paint is likely to be subjected to the influence of gases containing sulphur, zinc is decidedly to be preferred to lead as the basis of the pigment to be employed, inasmuch as zinc sulphide, instead of being black like lead sulphide, is of a light colour.

Zinc white is an oxide of zinc prepared by burning metallic zinc in a retort or furnace in a current of air, the zinc oxide passing over a bridge into a chamber, in which it is collected. It is then placed in canvas bags, and pressed into a hard mass with the object of increasing its density. It may also be prepared by precipitation from solution by means of lime, drying and calcining at a red heat. By whatever method it may be prepared, it will not compete with whitelead as regards density, neither will it stand the same amount of exposure to the weather.

A patent white sulphide of zinc paint is manufactured at Liverpool by the Sanitary Paint Company, which consists of a mixture of sulphide of zinc and sulphate of baryta, produced by adding a solution of sulphide of barium to a boiling hot solution of sulphate of zinc. The precipitate produced is pressed, dried, and ignited in a furnace to drive off excess of sulphur. It is then levigated with water to wash out soluble salts, and the pigment is completed by again pressing, drying, and grinding. This paint, when not properly manufactured, has sometimes been found to become discoloured under the influence of strong sunlight, the dark tinge which it assumes passing off again after a few hours.

For coating iron work the black and red oxides of iron have been extensively employed for many years; one of the first paints of this description was introduced about thirty years ago under the name of Torbay paint, from its having been prepared from a brown iron ore found at Torbay, in Devonshire, to which various tints from a light brown to a very dark red can be given by altering the conditions under which it is roasted. The black oxide of iron, which is obtained as a bye product in the manufacture of aniline dyes, is also employed in the preparation of a paint for iron work. These last-named metallic oxides have not, however, the power of combining chemically with the linseed or other oils used for grinding with the pigment to the same extent as is the case with oxide of lead, which, by combining with the fatty acids of linseed oil, readily produces a soap such as that known under the name of lead plaster.

There is another pigment of some importance that is now manufactured on a considerable scale at the works of the Bristol Sublimed Lead Company, obtained from the condensation of the fumes given off during the process of lead smelting, the escape of which into the atmosphere is known to produce such deleterious results in the neighbourhood of lead works. The fumes consist mainly of sulphate and oxide of lead in the condition of a very fine, impalpable powder, which cannot readily be made to subside, the various attempts that have been made for the achievement of this object having been the subject of numerous patents. It is, however, now successfully accomplished by means of flannel bags, through which all the gases and volatilised products from the lead furnaces are forced, the solid particles being retained by the flannel. This powder is collected, and when re-sublimed yields a white pigment which varies in its composition according to the nature of the lead ores employed, but usually consists of about 70 per cent. of sulphate of lead, 23 per cent. of oxide of lead, with a little oxide of zinc. In point of colour it cannot compete with ordinary white lead, but it forms a good basis for lead-coloured paints, of which vast quantities are required.

I stated, at the commencement of these lectures, that it was not my intention to enter more fully into the nature of the great variety of substances used for painting than was necessary to give a short description of the pigments usually employed as a basis for the commoner kinds of paints, most generally used for the preservation of wood and iron. All that I have endeavoured to accomplish has been to afford some information as to the general principles upon which the technical value of the different building materials passed under review depends, without going more fully into details than is necessary for explaining the matter in hand, and occupying more time than a course of lectures on so wide a subject permits.

Miscellaneous.

PARIS EXHIBITION OF 1889.

The *Times* correspondent sends the following information under date August 5:—The Minister of Commerce has appointed committees intrusted with with the organisation and lectures to be held during the Exhibition of 1889. As the subjects to be dealt with are very varied, the work is not to be performed by one committee. A superior committee, will, however, be appointed to decide on all difficulties that may arise with reference to the meetings and lectures. The questions to be discussed will be arranged under the following heads:—(1) Literature, (2) the fine arts, (3) history and archæology, (4) the mathematical sciences, (5) the physical and chemical sciences, (6) the natural sciences, (7) the geographical sciences, (8) political economy and legislation, (9) hygiene, &c., (10) social economy, (11) education, (12) civil engineering, (13) agriculture, (14) industry, and (15) commerce. The Ministry of Commerce has appointed a committee for each of these sections, and the list of names includes a very large number of the most eminent members of the Institute, professors, *savants*, and men of letters of France. A statement drawn up by the Board of Management of the Exhibition with reference to the meetings and lectures says:—

"The questions which will be treated in them, and the discussions to which they will give rise, may result in the establishment of an agreement as to common action among the men of science, manufacturers, merchants, and administrators of different nations at the close of these meetings, and on some special points the various Governments may perhaps even be led to adopt certain common measures. In this way it will be possible to discover the conditions of uniformity in weights, measures, and coins, to lay down some international sanitary regulations, to bring about an understanding among nations to obtain comparative statistics, and to divide among them some great scientific works, such as the preparation of a map of the stars, and the determination of points connected with the form of the globe."

The statement afterwards refers to questions viewed differently in different countries, such as the hygiene of towns, prisons, and the liquor question, and points out that, although differences of climate and race may render varied solutions necessary, it is most important to know what has been done, and to collect information on these subjects for future use. As regards the lectures, the subjects to be treated are, it is said, those which are of general utility, and especially those which exhibit the progress made within the last century in all departments of human activity.

TREES OF LONDON.

Many of the old plans of London, which are bird's-eye views rather than maps, indicate avenues and plantations that have long since disappeared. Time and storms laid low one tree after another; the self-sown young ones had but poor chance against the increasingly polluted atmosphere, and the wanton destruction of young roughs; and the guardians of our highways and public gardens gave scant attention to the maintenance of summer shade and verdure. Above all, the loss of green in London was due to the builder. It is true, as one square after another was built it was "laid out," but this did not compensate for the wholesale felling of old timber, as one estate after another was cleared for building.

The last twenty years has seen a reaction, planting has been revived, and at no time more extensively than in the last three years. The newer parks, such as Battersea, Victoria, and Kennington, and "greens," like Camberwell and Paddington, are each year richer in foliage, and the avenues on the Embankment have grown large enough to add to the effect of the view, and give shelter to pedestrians; where bright gardens, too, gladden the eye, and afford pleasant resting places. From the time since St. Botolph's set the example, our grim and neglected churchyards have gradually been made to bloom with flowers, and young trees increasingly add to the refreshing colour. From Westminster Abbey and St. Paul's, down to small disused churches in "slummy districts,'' the effects of planting are to be seen.

The public seem to be gradually realising the fact that attention to beauty in our highways and public places is as valuable at least as in the design of a textile fabric, a wood carving, the lines for a carriage, or any of those "studies" for which art medals are usually given.

This last spring the churchyard of St. Martin's-in-the-Fields has been planted, and among other large churchyards, that in Chelsea has not only been planted, but laid out as a garden. The parade ground of the Horse Guards, around the Prime Minister's official residence, has also been planted, and over eighty trees have been added to those in the Hyde-park end of the Green-park, while many small groups are now to be seen in it elsewhere.

It is, however, in the busy thoroughfares that the change is most marked. Just as the new Northumberland-avenue was planted as soon as completed, so was Shaftesbury-avenue; and this last spring the new Charing-cross-road has been planted, thus carrying a line of trees close to the Seven Dials, and adding to the amount of green to be seen in Trafalgar-square. Many of the main thoroughfares leading to the suburbs have also been planted. For thoroughfares, the plane is almost everywhere adopted. It early shows a bright green leaf, and keeps its colour even when elms seem to fail. When the old elms in the

Brompton-road were felled, planes were subsequently substituted. Oaks have almost entirely disappeared. The plane seems better suited to London than any other tree, and no finer examples are to be seen than in Berkeley-square. As a proof of how bright grass may look, even alongside a main road, there is perhaps no better illustration than the Cromwell-road Museum Garden.

But to maintain the beauty it cannot be forgotten that trees in thoroughfares need regular pruning, and frequent attention to the pavement and road around them.

*THE ELECTRIC LIGHT ON THE ISLE OF MAY.**

The electric light having been sanctioned by the Board of Trade, who, indeed, first suggested its introduction at the Isle of May, on the ground that "there was no more important station for a light on the Scottish shores, whether considered as a land light for the guidance of the extensive and important trade of the neighbouring coast or as a light to lead into the refuge harbour of the Forth," plans and specifications were prepared by Messrs. Stevenson, and the new light was installed on December 1st, 1886. It was originally intended by Messrs. Stevenson to use the British compound Victoria dynamo, giving a continuous current and supplying a single automatically-fed arc-lamp, with the positive carbon below. This system was selected as being at once cheaper, and as giving a stronger light-power for the engine-power applied than the magneto-electric machines which had hitherto, with success at least, been exclusively in use in lighthouses. The placing of the positive carbon below was adopted in order that the strongest light might be thrown upwards so as to be dealt with by the upper part of the dioptric apparatus, and thus be more effectively utilised. Eventually, however, recourse was had to the more expensive alternate current machines of De Meritens, which, though not so powerful, are admirably steady in working, and had given excellent results in several lighthouses, and also at the South Foreland experiments. The generators at the Isle of May are two of De Meriten's alternate current magneto-electric machines of the L type, and are of the largest size hitherto constructed, weighing about four and a-half tons each. The lamps are of the Serrin-Berjot pattern, and the carbons of 1·6 in. diameter, but, if desired, 2 in. carbons may be used. The rate of consumption of the 40 mm. carbons is $1\frac{1}{4}$ in. per hour, or 2 in. including waste. The power of the arc is estimated at 12,000 to 16,000 candles, when one machine only is running. The dioptric apparatus, which was manufactured from Messrs. Stevenson's designs by Messrs. Chance, of Birmingham, is of a novel description, the condensing principle being carried further than in any apparatus previously constructed. This principle consists in darkening certain sectors by diverting the light from them and throwing it into the adjoining sectors, so as to reinforce their light, the result being that the light from this apparatus is about 3,000,000 candles when one machine is in use, and with both machines 6,000,000—that is about 300 and 600 times more powerful than the old fixed oil light. When the three-wick oil lamp is put in the focus of this apparatus, the emergent beam is more powerful than the old fixed oil light with a four-wick lamp, which was 9,446 candles. The light has been picked up and recognised by sailors at 40 and 50 miles off by the flashes of illumination on the clouds overhead, although the geographical range of the light is only 22 miles. The new buildings, engines, electric machines, lamps, &c., have cost £15,835, and the buildings, lantern, &c., previously on the island, which have been utilised, may be valued at £6,600. Thus the total cost of the installation may be taken at £22,435, and the cost of maintenance will exceed £1,054 per annum. These figures are very moderate, considering the great power of the light and the isolated position of the lighthouse. To compare the cost of this installation with what it would have been if oil were the illuminant, there must be added to the above £6,600 for buildings, a sum of £2,925 for the cost of the apparatus and machine, &c , making a total of £9,525, while the cost of maintenance would have been £330 per annum. Taking these figures, and adding to the maintenance $3\frac{1}{2}$ per cent. on the original outlay, it is found that while the oil light would cost 3·49s. per hour and 0·00017d. per candle-power per hour, the electric light costs 9·66s. per hour, or two and three-quarter times more, and 0·000038d. per candle-power, considerably less than what the oil light would cost per candle-power. This is taking the electric light power of one machine. Surprise has frequently been expressed by masters of vessels and by residents on the neighbouring shores who live in view of the Isle of May light, that this light, which is so extremely brilliant in clear weather as to cast shadows at a distance of ten and fifteen miles, is so cut down by fog, that some even go the length of believing the old oil light was better in fog. All who have experience of the electric light are quite prepared for the first part of this statement, while the last, it need hardly be said, is a mistake, inasmuch as the electric arc has been proved, both by experiment in natural and artificial fog, and also on existing lighthouses lighted by electricity, to be in all circumstances of weather the most penetrating. Every night at twelve o'clock the light keepers at St. Abb's Head, twenty-two miles distant, where there is a first-order flashing light, and one of the most powerful oil lights in the service, observe the Isle of May light,

* Abstract of a paper read by Mr. David A. Stevenson, at the meeting of the Institution of Mechanical Engineers in Edinburgh.

while the keepers there also observe the St. Abb's Head light. The result of the last five months' observations is that the Isle of May light is seen one-third oftener from St. Abb's Head than the St. Abb's Head light is seen from the Isle of May. It is perfectly true, however, that the superiority which is so apparent in clear and rainy weather is very much reduced in hazy weather, and practically disappears in very dense fog. Looking to this fact, and to the large first cost and annual maintenance, the author feels that the conclusion arrived at by Trinity House is sound—namely, that electricity should be used only for important landfall lights. If, however, the most powerful light is desired, independently of cost, then the electric arc has no rival.

General Notes.

Exhibition of Works in Wood.—The Worshipful Company of Carpenters will hold a second Exhibition of Works in Wood at their hall, London-wall, London, in the early part of next year. Full particulars as to time and conditions will be announced early in October.

Kola Plants.—According to the *Chemist and Druggist* (6th August), the Marseilles Botanical Gardens have shipped by s.s. *Anadyr* to Saigon four Wardean cases containing 280 kola plants for Cochin China. Next month the same quantity is to be shipped by the steamer following for the same port. Mr. Lascelles-Scott, referring to this notice, points out that the French Government, in view of the great value of kola paste and kola chocolate as adjuncts to military rations, are making this experiment of cultivating the kola plant in one of the colonies, so that a more regular supply of the nuts may be obtained.

Italian Silk Trade.—The *Deutsche Handels Archiv* reports the fact that great efforts have of late years been made in Italy to improve the character of the silk produced. One result of these endeavours is said to be the increased business which has resulted with North America, where manufacturers had previously drawn their supplies principally from Japan. The facilities which exist at Milan for warehousing and disposing of cocoons have so far altered the course of trade, that the stock at the end of 1889 was 106 tons at Marseilles, and 493 tons at Milan, while at the end of 1878 the figures had been respectively 511 tons, and 65 tons; the positions of the two markets having thus been reversed.

German Prison Labour.—According to an official return, there were, during the German official year 1885–86, a total of 17,636 prisoners employed in work for third parties; the number engaged on industrial work being 17,058, and the remainder being employed in agricultural and other kindred avocations. Amongst the various sections are quoted:—Metal-work, lamp-making, &c., 296; toy-making 208; and iron goods manufacture 201. The trades most largely represented—are cigar manufacture, 1,930; joinery, 1320; and shoemaking, 1336. The total receipts from this source was £211,654; while the expenses were £80,788; the surplus thus being £130,866. The wages were highest in Lüneburg, and lowest in Breslau and Berlin.

Arsenic in Matches.—The "Journal of Chemical Industry" extracts a note from the *Chemiker Zeitung* on this subject. Arsenic was detected in matches obtained in Jena by the characteristic smell of arsenic trioxide, which was evident immediately after striking, and before the sulphur began to bnrn. The match heads had a black covering with a metallic lustre, and contained much lead, partly present as red lead. The quantity of arsenic was, however, so small, that it could not be detected as sulphide, even by treating fifty match heads with hydrochloric acid and distilling, or by fusion with nitre and sodium carbonate. On the other hand, its presence was confirmed by Gutzeit's reaction. Ten matches were burnt at once under a porcelain dish, and the film treated with bromine water (to remove sulphur dioxide), washed into a flask, and reduced with zinc and hydrochloric acid, when the yellow colouration on a piece of filter-paper, moistened with a drop of nitrate of silver, was obtained.

Brewers' Exhibition in Paris.—The leading brewers in France are preparing an exhibition of beer and of the products and apparatus used in brewing, which is to be held in Paris this autumn. The brewing trade has of late years increased very much in importance, as, owing to the inroads of the phylloxera and the mildew, the consumption of wine has to some extent been replaced by that of beer. The quantity of beer consumed in different parts of France varies, however, very much. The total quantity of beer brewed in France has for the last three or four years averaged about 180,000,000 gallons, while the imports of foreign beer, which reached 9,336,195 gallons, have been reduced to 6,591,195 gallons. The value of the foreign hops imported into France is about £200,000 in ordinary years, but while importing these considerable quantities of beer and hops, France exports more than 50,000 tons of barley, of which about half comes to England. The French brewers hope that this exhibition may lead to the institution of a school of brewing similar to those existing in Germany and Austria.

Journal of the Society of Arts.

No. 1,814. Vol. XXXV.

FRIDAY, AUGUST 26, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1888.

The Programme for 1888 is now ready.

The subjects in which Examinations are held are as follows:—(1) Arithmetic; (2) English, including composition and correspondence, and *précis* writing; (3) Book-keeping; (4) Commercial Geography and History; (5) Shorthand; (6) French; (7) German; (8) Italian; (9) Spanish; (10) Political Economy; (11) Domestic Economy; (12) Theory of Music; (13) Practical Music.

The Examinations are held at all places in the United Kingdom where suitable Committees can be formed. A fee of 2s. 6d. is required from each candidate in each subject, except Practical Music, for which special fees are charged. 1st, 2nd, and 3rd class certificates are given in each subject. Full details of the conditions of the Examinations, together with syllabuses of the subjects, will be found in the Programme, which can be had gratis on application to the Secretary.

The Examinations will be held on the 9th, 10th, 11th, and 12th of April.

The Practical Examination in Vocal and Instrumental Music will be held in the Society's house during the week commencing on May 21st.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.
7. Hand-tooled Bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday, 3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered will be found in the number of the *Journal* for July 8th, and can be obtained on application to the Secretary.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for July 29th.

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

Miscellaneous.

POPULAR BEVERAGES.

By P. L. Simmonds, F.L.S.

Part II.

Resuming the subject touched upon in the *Journal* for July 29th (see *ante* p. 837), there are still many curious beverages, refreshing or intoxicating, in use in different countries worthy of a brief description. To enter into details respecting their preparation and the extent of their consumption would be impossible in the limited space at command in the *Journal*.

A pleasant beverage, called "Chica de Mirtilla," is obtained in Chili from a species of myrtle berries (*Mauria simplicifolia*). These are about the size of a large pea, of a deep red colour, and of a peculiarly sweet and delicious aromatic flavour. They are prepared by crushing them in water, and allowing them to ferment for a few days. The black cluster berries of the Molle tree are also gathered for this purpose by the Indians. They have a combined flavour of juniper and pepper.

Chica is also made from the saccharine liquors of the Algarroba or Carob tree (*Ceratonia siliqua*), by merely infusing them in water, straining, and allowing the infusion to ferment. At the expiration of three or four days it is very palatable, and if proper attention were paid to it, a very delicate wine might be obtained.

Masato is another South American drink, made either from ripe plantains or yucca (*Cassava*) roots boiled till they are quite soft. These are reduced to a pulp by beating them in a trough; this pulp is then put into a basket lined with leaves, and allowed to ferment for two or three days. When it is wanted for use, a spoonful or more is taken out and put into a tutuma or calabash, bored full of holes like a cullender. A quantity of water is added to it, and the whole is rubbed through the holes of one gourd into another without holes, which serves as a bowl to drink out of, or small totumas, are filled from it and handed round. Stevenson, who describes the preparation in his "Travels in South America," says he was highly pleased with the drink, and scarcely took anything else for his breakfast. The taste is a sub-acid, but remarkably agreeable.

The sap of the *Bromelia Pinguin*, when properly prepared and allowed to ferment, makes a pleasant drink, which is considered little inferior to champagne.

Mention has already been made of the succulent peduncle of the cashew nut, from which an excellent spirit has been distilled, with diuretic properties similar to the best Hollands. The fruit roasted when ripe, and added in slices to punch, communicates an agreeable flavour to it, and if the punch thus prepared be bottled, it soon ferments and thus becomes a delicious sparkling liquor. Advantage has been taken of this readiness to run into the vinous fermentation to manufacture an excellent wine from this fruit. Mr. J. H. Tobin, of Nevis, some years ago devoted much time to experiments on its manufacture. The following was his recipe. Mix two parts of the expressed juice with one part of water, putting to every gallon of juice $3\frac{1}{2}$ lbs. of the best sugar, and to every gallon of water 4 lbs., and adding six gills of lime juice for every 8 lbs. of sugar. Bung the cask down tight before the fermentation has wholly subsided, and fine in the usual way with eggs.

According to Bridge's "Annals of Jamaica," Cassava formed the component part of the principal beverage of the Indians of the West India Islands, and was much used also by the Spaniards. It was called "ouycou," and was thus made. A large earthen vessel was nearly filled with 60 quarts of water, into which two cassava roots (*Janipha manihot*) were broken, with a dozen sweet potatoes (*Batatas edulis*), four quarts of sugar-cane juice, and twelve ripe bananas. The vessel was closed and the mixture left to ferment two or three days, when, the scum being removed, the clear liquor was ready for use. It is said to have been strong and refreshing, but was surpassed by the "mabey," a species of Indian beverage more resembling wine, and which a French author affirms was "un vin claret, aussi fin que le meilleur Poire du Normandie." It was thus made:—Into thirty quarts of water are put two of clarified syrup, twelve red sweet potatoes, and as many oranges cut into quarters. The mixture is then allowed to ferment about thirty hours.

Nature very far from having, as is generally thought, deprived the torrid zone of fruits adapted to the production of an agreeable vinous drink, capable of alleviating the heat which is felt by the inhabitants of those burning countries, has enriched it with the cane, which presents in its sugar the purest aliment, and in its fermented juice the most abundant source of a wholesome drink. The cane lends itself to every taste; like the apple or grape, it is made optionally to yield cider, wine, or brandy.

A Dr. Dutrone, of San Domingo, published in the close of the last century, some essays giving information as to wine he made from the juice of the cane. "Having observed in Normandy (he says) that in order to obtain good cider from different kinds of apples, it was necessary to have them in a garret for a certain time. Accordingly, I left the canes to themselves, and after eight or ten days they assumed the same vinous smell of apples. I had them pressed —the already far advanced spirituous fermentation contained in the juice expressed, and in five or six days I obtained a wine perfectly analogous to cider." It must be strained and drawn off after twenty-four hours' settling. In this state the wine is too sweet for use as an ordinary drink; it is, therefore, advisable to leave it alone for some time, as is done with cider. If immediately bottled it will, in a short time, sparkle and pop like champagne. Its colour is more or less of the amber, according to the state and quality of the canes. By adding to the must the juice of some fruit, say of the pine-apple, orange, lime, guava, or the mammy-sapota—a wine is obtained possessing the aroma and flavour of the fruit employed. It may also be coloured red with the juice of the prickly pear fruit. A fermented liquor called cariacou is made in Cayenne from a mixture of cassava, sweet potatoes, and cane juice.

In Brazil and the West Indies wine is made from oranges. The fruits are collected and exposed to the sun for three or four days. They are then cut into slices without being peeled, and the juice squeezed out by twisting; the cloth in which the slices are placed is left undisturbed for twenty-four hours. The essential oil which swims on the top is skimmed off with a spoon, or absorbed with a plug of cotton

To every 25 lbs. of liquid is added brandy 18 degrees over-proof, and 12 lbs. of syrup of sugar. This mixture, thoroughly stirred up, is put into jars or pots, which are covered up with wood and lime, and buried two feet in the ground. At the end of two months the wine is fit to drink, but its quality, like that of most wines, improves with age.

In Brazil, wines have also been made from the pine-apple, from the jabuticaba (*Eugenia cauliflora*) and from the *Passiflora quadrangularis*, which have been taken for Spanish wines.

Coffee berries and bananas likewise afford an excellent spirit. By fermenting tamarinds with a portion of sugar, a good wine may be obtained. Plantain wine is an extremely palatable and wholesome drink, obtained after steeping the ripe fruit, and allowing it to ferment for twenty-four hours.

In Mexico an alcoholic drink known as sotol is obtained from the sap of a bromelaceous plant (*Dasylirion texanum*). This plant sometimes covers many square miles of arid, stony slopes. The base of its leaves and young stems are full of a sweet, refreshing, and nourishing saccharine matter. It is from these, after a process of boiling and fermenting, that the alcoholic liquor is distilled, and from one large basal part of the leaf nearly a pint of this is to be procured. It is limpid and colourless, with a peculiar penetrative odour, and a taste which, though a little bitter, has been compared to the smoky flavour of Scotch whisky. It is largely consumed locally, and seems to have little deleterious effect on the human system. The Mexican barrel of sotol, containing about 28 gallons, is sold at 15 dollars, and the liquor is retailed at from 30 to 40 cents. (15d. to 20d.) a quart.

An agreeable vinous liquor made from honey was formerly in much repute in this country, and is still popular in Africa and other parts. The use of this substance as one of the ingredients in drink is of very ancient date. When fermented, honey water obtains the name of mead, or metheglin, which is in fact honey wine; indeed the Germans call it by that name. Mead is said to have been the principal beverage of the Britons before the use of malt liquor, and even long after the introduction of beer, mead was a favourite drink. Queen Elizabeth was so fond of mead as to have had it made every year for her. Mead formed the drink of the Scandinavians, and was celebrated by their bards. Primrose blossoms were used by them to flavour it.

The manufacture of tedge, or honey wine, in Abyssinia, is a royal monopoly, it is not publicly sold, but there is a kind of conventional licence (not exactly smuggling), by which, for double or treble its value, this beverage may be obtained. The process of preparing this liquor is very simple. Cold water being poured over a few small drinking-hornsfull of honey placed in a jar, is well stirred up; to this is added a handful of sprouted barley (*biccalo*) scorched over the fire and ground into a coarse meal, with the same quantity of the leaves of the gaisho, a species of Rhamnus, which, when powdered, yield an intense but transient bitter, like gentians or hops. The mixture being allowed to stand for three or four days, ferments, and is generally drunk in that state, but is then rather a curious kind of muddy beverage, full of little flocculent pieces of wax. It is more agreeable, but not unlike in appearance or character very strong sweet wort. To a superior kind made for the king's own table, besides the biccalo and gaisho is also added a kind of berry called *kutoh*, which grows not unlike the fruit of our elderberry, and may possibly be the production of some tree belonging to that species. The jars containing this are sealed with a large cake of clay, mixed with the lees of the decanted liquor. This kind of tedge is allowed to stand for several months before it is used, and is called "barilla." It is handed to guests in small Venetian bottles of green glass, the fracture of one of which is a grievous offence, and the king always makes the careless party pay for it.

In Madagascar, too, they make a honey wine, a composition of three parts of water to one of honey, which they boil together, and skim, after it is reduced to three-fourths. They afterwards put it to ferment in large pots of black earth. This wine has a pleasant tartish taste, but is too luscious.

The juice of the purple fleshy petals of the *Coriaria ruscifolia* affords a grateful beverage to the Maories, and a wine like elderberry wine used to be made from it by the missionaries.

In parts of Southern Africa the natives make two different kinds of liquor, one called "epeakla," and the other "wocahnyeye." The first is prepared in the following manner. A large quantity of maize with a proportion of water, is put into a wooden mortar, pounded for half-an-hour, and afterwards placed in the shade to ferment. At the end of two days it is boiled, and when cold a small decoction of millet well pounded is added, and the whole after standing a few hours strained through a meal bag, from which the liquor oozes perfectly pure, and of a milk-white colour. In one day it is drinkable, the next sour, and less than two bottles will occasion inebriation. The second named liquor is obtained from the *mancanyeye*, a fruit resembling the guava. A small hole is cut in the fruit through which the juice is squeezed into a large boiler, where, after having stood some time over the fire, it remains to ferment until the next day. More juice is then added, and the same operations repeated. It then becomes drinkable, and will continue so for three days. It has scarcely any colour, but a sweet and pleasant taste, and is not of so intoxicating a nature as the other native beer.

The Basutos make a beer in this manner:—The grain is left to sprout, when it is ground and enough boiling water poured upon it to make a paste. When cold, water and yeast are added, and when it has fermented for two or three days the liquid is placed on the fire and boiled several times to strengthen it.

For the same purpose they add a few handfuls of fresh flour, when it is afterwards strained.

Passing to India, we find that the tribes of the Western Ghâts make an intoxicating drink called "barr" from the milky sap of the mudar (*Calatropis gigantea*). In Goa a wine very fairly resembling port is prepared from the fruit of *Eugenia jambolana*. The Santals are said to use *Ruellia suffruticosa* when they wish to prepare a pleasant beverage from rice, but add *Clerodendrum serratum* to make this intoxicating.

A spirit is distilled from the saccharine flowers of the mohwa (*Bassia latifolia*) and also from the seeds. It is much like Irish whiskey, having a strong smoky and rather fetid odour, the latter disappearing with age. This spirit is in popular repute amongst the natives (especially the Parsees) in Western India.

A poor kind of beer called "quass" is made in Russia from rye; it much resembles what is known as treacle beer. Another Russian popular beverage is "buhsa," prepared with millet and water, and occasionally mares' milk. After being bottled it ferments, and becomes effervescent. The taste is tart, with an unpleasant after *goût*, and it is very intoxicating. Hydromel, a fermented mixture of honey and water, is not unlike rather flat ginger beer.

From the fruit of the merisier, or wild cherry, there is obtained by distillation a liqueur much appreciated, known under the name of "kirschwasser." The mashed cherries are fermented with their kernels; this liqueur is made in Germany, Switzerland, the Vosges, and the Duchy of Baden. The best, however, comes from the Black Forest.

The common beverage of the native tribes of the wilds of Tartary is "koumiss," made from mares' milk, the use of which has now spread over Europe and America. It has been commended as a refreshing and wholesome drink for general use. Chemical research and experience have established the fact that cows' milk makes an equally good koumiss. It is a white liquid, more effervescent than champagne, with a slightly acidulous, sweetish taste, somewhat like that of buttermilk, and leaving a fresh, very agreeable aftertaste.

In some of the Pacific islands an intoxicating beverage is obtained by the natives from the root of *Piper methisticum*, or *inebrians*, and called "kava." The manufacture is not a pleasant one, the dry root being masticated, and placed in a large bowl, on which water is poured, and the whole is squeezed and macerated by hand, till the juice is expressed, which is handed round to the company. In the Fiji Court of the late Colonial Exhibition, an attempt was made to introduce kava here, but this was a distilled spirit, very different to the native kava.

The Egyptians have many sherbets or cooling drinks besides lemonade. A sherbet is prepared from mulberries, another from sorrel; one is made from raisins, one from a strong infusion of liquorice root, and another from the sweet pods of the locust or carob tree. The most esteemed is prepared from a hard conserve of violets, made by pounding the flowers, and then boiling them with sugar. The violet sherbet is of a green colour.

The question of cooling summer drinks in the sultry weather lately experienced is one of importance to large numbers. The refreshing influence of acids is well known. From the number of acids which is found in nature, and the tendency of many artificial substances to become sour, it is evident that acids and sours are essential to our life and wellbeing.

The degree of acid employed to drink will necessarily be largely a matter of taste. Many will find relief from a beverage composed of diluted and unsweetened lemon or lime juice, or rough Hereford cider with an equal part of any pure form of effervescing water.

OUTINIAN SOCIETY.

The society which took this uncouth name was founded in 1818 by Mr. John Penn, a descendant of William Penn, the quaker founder of Pennsylvania. A design for a medal to commemorate this event was prepared, on the obverse of which was the representation of Penn holding the charter of Pennsylvania, and this inscription—"William Penn, deceased, 1718; Outinian Society founded 1818." On the reverse was a representation of Ulysses deriding Polyphemus, and from the name *Outis*, which Ulysses assumed in the Cyclops' cave, the title of the society was formed. As the ancient Greek traveller supported a good cause under that name, so the society undertook, whether for the repression of injustice or exercise of benevolence, to apply itself to remedy those evils which prompt the remark that the business of anybody is that of nobody. Thus neglected duties and neglected arguments were mainly attended to by the founders of the institution. The society owed its existence to a poem entitled "Marriage," published in the *New Monthly Magazine* in 1815, and republished in 1816, and was at first called the Matrimonial Society, but it soon changed its name to the Outinian Society. The objects of the society were to be obtained by the holding meetings of both sexes, at which critical and ethical lectures were delivered. The mode adopted to obtain these objects appears absurd enough, but the secretary put forward, as an excuse for the apparent trivialities of the scheme, the fact tha Bishop Berkeley, who distinguished himself in the early part of his life by exact speculations, concluded his career of science by composing his *Siris*, in which the medical properties of tar water are extolled. In spite of the triviality, it is thought that some notice of a forgotten society that existed for seven or eight ye ars may be of interest.

The Rev. D. Rivers read lectures at Saville-house,

Leicester-square, and afterwards at Mr. Penn's house, 10, New-street, Spring-gardens, which was styled the Portico, because it was the only house in the street with a portico attached to it, and for several years the lectures delivered by different persons were continued every Saturday at this house during the London season. The tenth lecture was given on the occasion of the marriage of the Duke of Clarence (afterwards William IV.) to the Princess Adelaide of Saxe-Meiningen, and the sixteenth lecture was delivered at Mr. Penn's country seat, Stoke-park. A missionary character was given to the association by the redelivery of the lectures in different parts of the country, such as Leamington, Cheltenham, Weymouth, Maidenhead, Uxbridge, Bath, Windsor, Southampton, and Lyndhurst. The reports of the meetings contained a statement of the number of visitors, by which it appears that the attendance was frequently very scanty; thus we learn that at Lyndhurst a torrent of rain fell at the time fixed for the meeting. The lecturer attended to fulfil his engagement, and the seventh lecture was read, but there were present to hear it only two ladies and three gentlemen, travellers staying at the "Crown" Inn. On another occasion, at Weymouth, the rain was so violent as to prevent any of the inhabitants from leaving their houses to hear the lecture. Some of these Outinian lectures were published under the editorship of Mr. Penn, and in 1822 appeared two quarto volumes, entitled "Records of the Origin and Proceedings of the Outinian Society," in which will be found engravings of some of the inventions noticed in this article.

One of the subjects treated of was the improvement of the drama, and the principles enunciated were exhibited in a tragedy by Mr. Penn, entitled *The Battle of Eddington*, which was publicly produced. It was suggested to Chateaubriand that he should translate *The Battle of Eddington* for production on the French stage. Patriotic writers were to be rescued from dependence on the caprice of newspaper editors, and with this object, announcements which had been rejected by the editors were to be received and exhibited during the season at the Outinian lectures.

The president of the society was Mr. Penn, and several noblemen held the office of vice-president. The manager was Baron Nolcken; the treasurer Roger Pettiward; the chaplain the Rev. J. Masters, and the secretary and lecturer Jonathan Richardson. The objects of the Society were chiefly social, and improvements in the manners of good society were aimed at, many of which improvements have since been carried out. The reason for noticing the doings of this forgotten society in these pages will be found in the fact that the secretary occasionally gave an account of new inventions which he considered worthy of the support of the members. It is remarkable that several of these improvements, although pointed out more than half a century ago, have only just been adopted. For instance, Outinian lamp-labels, for indicating the names of the streets at night, were actually set up in certain parts of the West-end as far back as July, 1824. Labels were placed by the society at the corner of Cleveland-street and St. James's-street, in Duke-street, York-street, King-street, and Charles-street, St. James's, and in Pall-mall East, and these were continued for some time, but the convenience does not appear to have been sufficiently appreciated to induce the parish authorities to enlarge the area of their use, or to renew those placed on the lamp-posts when they were worn out. Besides those referred to, labels were placed in the two short streets leading from Pall-mall to St. James's-square (John and George-streets), but these were removed by the parish officers on account of an Act of Parliament passed to prevent illuminated letters becoming nuisances in those streets where there is a temptation to indicate coffee-houses or similar places of meeting there situated.

In 1820, an early form of combined fire-engine and fire-escape, invented by Mr. Felton, of Birmingham, was exhibited and described to the Outinian Society, and figured in the records of their proceedings. The engine is placed below and a gallery above, between the two is a ladder which could be used by the fireman when playing water on the fire, and also as a means of reaching the gallery when placed against the upper window of a burning house for the purpose of rescuing the inmates.

Another invention brought under the notice of the members was a safety saddle, attached to which in front were iron supports that touched the ground when the horse stumbled, and kept him from falling down. An objection was made to this contrivance that it had a very singular appearance when not required, but the inventor answered this by remarking that it would only be a nine-days' wonder, and when in constant use no one would think it singular. An Archbishop of Dublin fell from his horse and fractured his collar-bone, and the *Morning Post* took advantage of the accident to draw attention to the Outinian safety saddle. A safety bridle was also produced.

A contrivance by which ivory balls were placed at the end ot the ribs of umbrellas and parasols, was invented by Mrs. Reid, of Charing-cross. The Outinian or town umbrella and parasol was thus supposed to be safer in the streets than those with the metal points projecting round the circumference of the silk, by which the eyes of the passers by were endangered. Amongst the many ingenious contrivances brought forward were breakfast and dining-room table waiters, bed pockets, and a covering for the shoulders of invalids sitting up in bed, to which the name Omocalypse was given. Special attention was paid to contrivances likely to add to the comfort of travellers. Thus bands were placed in the travelling carriages to hold hats, such as are now common in railway carriages; and a strip of sealskin

was placed along the top of the outer wooden blind, so that when the exterior of the carriage window became obscured by rain or other causes, the wooden blind could be let up and down and the glass cleaned by this means. The Odoscope was a map or plan of a district, pasted on wood and varnished, on which pegs might be placed to mark the spots where the driver was to stop the vehicle. Another contrivance was for the advantage of short persons in a crowd; it was a sort of stool which doubled up, and could be put in the pocket when not in use. It was styled an elevator.

It will be seen from this enumeration that the majority of the inventions brought under the notice of the society were connected with those minor comforts which were not likely to attract much attention except among the well-to-do, and those who had but few serious evils to contend with. They carried out, however, the idea of the society contained in its name that what is everybody's business is nobody's, and therefore suited to the consideration of those who were gathered together under the name of *Noman*. One of the proposals is of more national moment, and has some interest at the present time. It was a proposal for establishing a colonial emigrant institution and public drawing school, but what means were taken for carrying out the proposal do not appear.

ST. PETERSBURG EXHIBITION OF THE NAPHTHA INDUSTRY.

The Russian Imperial Polytechnic Society proposes to hold this autumn an exhibition of appliances and materials for artificial illumination, and of objects relating to the naphtha industry, and the society is desirous of co-operation from abroad. Every facility will be given to foreign exhibitors, such as exemption from Custom-house duty and patent rights for their various exhibits.

The programme of the Exhibition includes—(1) Historical collections illustrating the progress of artificial illumination from the earliest times; (2) lighting by means of solid or liquid illuminants, either vegetable or animal; (3) gaseous illuminants, and apparatus for their production and application; (4) electric lighting; (5) special sources of light and appliances for lighting; (6) lamps for burning mineral oils; (7) photometry; (8) petroleum and its products, appliances used in the extraction, storage, and transport of petroleum, and in the manufacture of its products; (10) mineral lubricating oils.

The Exhibition will open in November, and the admission of objects will take place from the 27th of August to the 27th of October. Besides medals and diplomas, the following prizes in money will be given:—

(1.) 1,200 roubles for the best type of lamp of simple and cheap construction, for use in peasants' cottages, capable of burning heavy mineral oils.

(2.) 1,000 roubles for a similar lamp, but of rather higher price.

(3.) 500 roubles for a stove capable of burning naphtha refuse for heating rooms.

(4.) 500 roubles for a primary battery for lighting incandescent lamps.

(5.) 1,000 roubles for a day and night military signalling apparatus.

(6.) 500 roubles for phosphorescent substances.

The first two prizes will be awarded by the Ministry of Domains, and the remainder by the Ministry of War, and all will be open to foreign as well as Russian competitors. Further particulars can be obtained by intending English exhibitors from Mr. G. Kamensky, agent for the Russian Ministry of Finances, 21, Blomfield-road, Maida-hill, London.

POTATO STARCH.

The preparation of potato starch has long been an industry of importance, and it is for the sake of its starch that the potato is so widely used as a food. One of our highest English authorities gives 15 per cent. as the amount of starch present (75 per cent. being water), but this is as the mean of several analyses. German analyses of different varieties give a range up to 20, 22, and even 25 per cent., so that the actual starch value would thus appear to vary in different varieties. But it may be questioned whether the same variety may not differ according to season as much as varieties differ one from another. Although in recent years many important improvements have been made in the processes, and the machinery used in starch preparation, only slight scientific attention has been given to the growth of potato crops. It is principally as a food that the potato is regarded, but to obtain the highest per-centage of starch must be the chief aim of the cultivator whether he is growing for the table or the manufactory.

Since the appearance of "Liebig's Agricultural Chemistry" in 1840, much chemical investigation has been directed to the cultivation of cereals, and now the most suitable conditions for their growth are fairly well known. The imperfect knowledge respecting potato growth is due to the fact that no chemist has made it a study. It is somewhat remarkable that though there is at present so much activity among physiological chemists in studying the process of the formation of starch in the leaves of plants, in not a single case, till within the last few weeks, does the potato appear as the plant chosen for observation. With regard to plants generally, it has been recently established (contrary to old beliefs) that the carbon of the starch ($C_6 H_{10} O_5$) in leaves comes from the carbonic acid of the air. The old belief was that it entered by the roots, dissolved in water. Allowing that the

process of formation of starch in the leaves, and the question of the part played by the chlorophyll cells, are matters of purely scientific interest, the fact of its formation there cannot be overlooked by the practical cultivator. Varieties differ much in foliage, and the number of starch-forming leaves vary. If it be clearly established that the total leaf area of a plant has direct relation to the amount of starch a plant forms, then those who grow potatoes extensively for the market cannot neglect to pay attention to the character of foliage. The question has become more complicated through the results of two experiments recently made. One is that the amount of light sufficient to form the green colouring matter of leaves (chlorophyll) is not necessarily sufficient to form starch. The other is that light when it has once passed through chlorophyll has lost its power to form starch, so that those leaves which are shaded by others form very little, perhaps none. In connection with a plant cultivated solely for the sake of its starch these are important facts to know, and though the experiments were made on other plants, there is no good reason to doubt they are equally true with regard to the potato.

Within the last few weeks it has been found from analysis of potato plants themselves that there is no trace of starch in the stem. Starch and sugar are readily convertible one into the other. It would appear, then, that the starch of the leaves is converted into sugar, and as such passes down the stem, and is then re-converted into starch in the tubers. What is the process of the formation of those starch granules, which are such favourite objects for the microscope, has not yet been studied, and hence there is no answer to the question, what is the cause of that condition popularly called "waxiness"?

The discussion that has been going on for so many years about "granulose" and "farinose" appears to be, for the present at least, drawing to an end with the agreement to call both "starch substances."

Boussingault, in 1836, studied the effects of temperature in relation to potato growth, and the effects of manures have been studied at Rothamstead, but starch formation has been a neglected subject. Now that attention is being given to it from a chemical and physiological point of view, hopes may be entertained that some scientific facts may be acquired and turned to practical use, for though the workers at present are few, others, seeing the importance of the subject, may take it up.

MINING INDUSTRIES OF ALSACE-LORRAINE.

Alsace is not rich in metals, but in the districts of Lorraine bordering upon Rhenish Prussia are found iron ore, copper, nickel, and to some extent zinc and tin. Iron is found in many localities in Lorraine. The iron ore is chiefly magnetic, and contains 65 per cent. metallic iron. Consul Ballow, of Kehl, says that the working of these mines began eight hundred years ago, and they are still far from being exhausted. The general output per annum is about 8,000 tons wrought iron, 6,000 tons cast iron, and 6,000 tons of steel. The coal employed amounts annually to about 12,000 tons, which come principally from Saarbrücken. There are in Lorraine 48 furnaces, 210 puddling and soldering ovens, and 86 steam hammers. Two-thirds only of the iron ore worked in Alsace-Lorraine is the product of the country, the remainder being imported from Westphalia, Rhenish Prussia, and Belgium. Besides the department of Lorraine, Upper Alsace produces some iron ore, the production averaging about 1,800 tons annually. The district of Lower Alsace takes an important though not a leading position in the steel trade of Germany. The production amounted to 8,500 tons in 1885. A large trade is carried on in the manufacture of cast steel for ship plates, and the following is the process of manufacture. From the iron ore mines are selected the purest ores, and those which are known by tests and experience to be the most suitable for crucible steel. In blast furnaces specially constructed for the purpose, these ores are converted into pig iron of a peculiar chemical composition. By the puddling process this iron is changed into steel and wrought iron containing a fixed quantity of carbon. The puddled steel is then rolled into bars of three-fourths of an inch square, and these, after being tempered, are broken into small pieces from two to four inches in length. The wrought iron is rolled into bars one inch and a fourth long, and one-third of an inch in thickness. By competent men each of these small pieces is carefully examined as to its proportion of carbon, and when the examination and the selection of the proper pieces is completed, this constitutes the material destined for the crucible. In order to obtain from it a product containing a fixed per-centage of carbon, the proportions of wrought iron and steel destined for the crucibles are carefully selected. These quantities are then carefully weighed, and each crucible receives about fifty kilogrammes of these materials. The crucibles are made by an improved process from materials particularly adapted for the purpose. They must be strong enough to endure the pressure of the contents in cold and in heat of almost 2,000 degrees, and so solid and clean as not to impart any foreign substance to the steel which is melted in them. Upon the proper construction of these crucibles largely depends the success of the castings. After being filled and hermetically closed, the crucibles are subjected to a preliminary warming, and are then put into melting furnaces specially constructed to receive them. The castings are oblong in form, and the various parts of the plates are then formed by forging, which serves the double purpose of greatly improving the metal and giving it shape. Great care is necessary in performing this work. Previously to forging the

great ingot it is subjected very slowly to a certain and precise degree of heat, which should be exactly equal throughout the entire mass. The forging process requires machinery of vast size and great strength, on account of the immense weight of the pieces which are to be handled, some of them weighing more than twenty tons. As regards the other metals found in Alsace-Lorraine, copper is found in a few places in Lorraine, and two hundred years ago there were large quantities of it, but at present these mines are almost exhausted. There is only one locality in Lorraine where copper is profitably worked. The ore which contains the copper is composed of magnesian limestone, and chlorated schist, and is frequently mixed with dorite and serpentine. The copper extracted from the ore is not worked in the country, but the greater part of it goes to France, where it finds a ready market. Zinc, nickel, cobalt, and antimony are found in small quantities in Upper Alsace. They are disseminated in the rocks of the Jura Mountains. There is one bed of antimony in the province of Alsace-Lorraine, in Upper Alsace near Ferette, composed of pure antimony and sulphur, with oxidated parts at the surface. Graphite has been discovered in Upper Alsace, and also red ochre. The beds vary in thickness, from three to eighteen feet, and are generally of easy access. In many cases the ochre contains some oxide of manganese, and retains its dark colour, and for that reason is much sought after by the trade. The working of the beds is very simple, consisting of washing and drying, and, when necessary, the calcination of the natural ochre. The only ore of phosphate of lime existing is the crystalised variety, called apatite or phosphate of lime. This ore is found in great abundance in Southern Lorraine, and is of superior quality, containing 86 per cent. of fluoride of calcium. The products of these mines are sent principally to England, where they are used in manufacturing the various description of artificial fertilisers. No coal beds of any importance exist in Alsace-Lorraine, although Lorraine is contiguous to a country so rich in coal mines as Rhenish Prussia.

FORESTRY REPORT.

A Select Committee of the House of Commons was appointed to consider whether, by the establishment of a forest school or otherwise, our woodlands could be rendered more remunerative. Eighteen members were appointed of the Committee, with the usual powers, and at the first meeting, on June 8th, Sir E. Lechmere was called to the chair. In all eight meetings were held, the last on August 3rd; and twelve persons, representing various professions, occupations, and interests connected with woodlands and forest management in England, Scotland, and Ireland were examined as witnesses.

The report, which was agreed to unanimously, has been published, and is, with very slight amendments, the draft report of the chairman. It should be mentioned that the Committee was originally appointed in 1885, and was re-appointed in 1886, when, in consequence of the general election, it had not time to consider the report.

The Committee directed its attention to the following points:—(1) How far there is need of some means of giving instruction to those engaged in the cultivation and management of woodlands; (2) how far the establishment of schools of forestry would meet that need; (3) whether a Board of persons representing various interests and associations connected with agriculture, arboriculture, and silviculture should be formed with the assistance of Parliament for the purpose of examination, granting certificates, and generally promoting the improvement of our woodlands; (4) whether by either or both of such means the cultivation could be made more remunerative.

In the course of the report it is pointed out that the woodlands in private hands amount to 1,466,000 acres in England, 163,000 in Wales, 829,000 in Scotland, and 330,000 in Ireland; and there is no doubt that the management of these 2,788,000 acres might be materially improved. Attention is particularly called to the New Forest, where over 40,000 acres of waste land are lying idle and worthless. It is also stated that there would be considerable advantage in an extensive system of planting in many parts of the kingdom, especially in the West of Ireland and in the Highlands of Scotland. It is to be noted that nearly every other civilised State possesses one or more forest schools, while in this country no organised system of forestry instruction is in existence, excepting in connection with the Indian service. The general conclusions to which the Committee came may be gathered from the words of the report:—

Your Committee recommend the establishment of a Forest Board. They are also satisfied by the evidence that the establishment of forest schools, or at any rate of a course of instruction and examination in forestry, would be desirable, and they think that the consideration of the best mode of carrying this into effect might be one of the functions intrusted to such a Forest Board.

As regards the Board of Forestry, the Committee submit the following suggestions:—

1. That the Board should be presided over by a responsible official (an expert by preference) appointed by the Government, and reporting annually to some department of the Government.

2. That the Board should be so constituted as to comprise the principal agencies interested in the promotion of a sounder knowledge of forestry, especially the various teaching and examining bodies, as well as the professional societies.

3. That the following bodies should be invited to send delegates to the Board:—

The Royal Agricultural Society of England, the Highland and Agricultural Society of Scotland, the Royal Dublin Society, the Office of Woods and Forests, the Linnean Society, the Surveyors' Institution, the English Arboricultural Society, the Scottish Arboricultural Society, and that the director of Kew Gardens should be a member *ex officio*.

That the Board should also comprise three members of each House of Parliament, and a certain number of owners or managers of large woodlands, a preference in the latter case being given to those who are in a position to afford facilities for study in their woods.

4. That the functions of the Board should be:—(*a*) To organise forest schools, or, at any rate, a course of instruction in forestry; (*b*) to make provision for examinations; (*c*) to prepare an official syllabus and text-book.

5. That the examiners should be required to examine in the following subjects—namely:—(*a*) Practical forestry; (*b*) botany; (*c*) vegetable physiology and entomology, especially in connection with diseases and insects affecting the growth of trees; (*d*) geology, with special reference to soils; (*e*) subjects connected with land agency, such as land drainage, surveying, timber measuring, &c.

The expense of secretarial staff and examiners need not, in the opinion of the Committee, exceed £500 a year, and the cost might be considerably reduced by fees for diplomas.

The fact that the Indian Government already incurs some expense in promoting the education of forestry students for the Indian Service suggests the adoption of the Royal Indian Engineering College at Cooper's-hill as a nucleus for the proposed forestry instruction.

Inducements might be offered to the agricultural colleges and the Surveyors' Institution to send their students for examination, by a system of exemption from examination in certain preliminary subjects, in respect of which the candidates could produce a certificate of proficiency.

THE CHINESE FAN PALM (LIVISTONA SINENSIS), AND ITS USES.

In the report of the superintendent of the Botanical and Afforestation Department of Hong Kong for 1886, the following interesting facts are given on the cultivation of the Chinese Fan palm (*Livistona sinensis*, Mart.), for the manufacture of fans.

The Rev. B. C. Henry, who has travelled much in the Kivangtung province, says in his book "Ling Nam," that the palm district extends about twenty miles from east to west, and ten miles from north to south. It appears that fan palm cultivation is confined to the San Ui district. In reference to this, Mr. Henry says "That the limitation of this industry is a matter of necessity and not of choice, is proved by attempts made at various times to cultivate the palm in other places, attempts that have always resulted in failure."

Judging from the appearance of the country in travelling through the delta, the reputed failure of the palm when its cultivation has been attempted in other places than the San Ui district could scarcely be attributed to soil, as everywhere this had much the same appearance of richness and constituency. Knowing the immense influence which winds have on the growth and success of not only delicate plants, but also on the hardiest of trees, it is possible that the uninterrupted sweep of certain winds over the flat land of the delta, combined with some other minor uncongenial circumstances, may be the cause of the failure of the palm for commercial purposes. The San Ui district is protected by lofty hills to the north and westward, which possibly afford the conditions of shelter that the palm requires for the development of perfect leaves suitable for the manufacture of fans.

The palm plantations are situated on flat alluvial lands, about six to ten feet above the water of the rivers, and creeks which run through the delta, and they are intersected with numerous open canals or ditches four feet wide or more, for carrying off the surplus water in the rainy season, and for retaining it, by means of wooden sluices fixed on the banks which surround the plantations or fields for purposes of irrigation.

The land is not wholly given up to palm cultivation, but other crops. as bananas, plantains, papays, oranges, peaches, ginger, betel-pepper plant, and various vegetables occupy shares of the ground.

The cultivation of the palm, and the manufacture of fans from its leaves, is a most important industry. According to Mr. Henry, the manufacture of the fans after the leaves have been cut gives employment to about one hundred firms, and from ten to twenty thousand people. When the plantations are made, the young seedlings are placed at various distances apart, in order that different kinds of leaves, which are produced from plants growing at close and wider distances asunder, may be obtained for the manufacture of fans, for which thick or thin, or large or small leaves are required.

"The most perfect plantation which I saw was about half a mile in length, and about a quarter of a mile in width. It was drained by means of open canals as above described. The main body of plants were in perfectly straight rows, and they were exactly 4 feet 4 inches apart; the stems were from 2 feet to 4 feet high, and they bore about six fully developed and perfect leaves, the pelicles (stems) of which were 5 feet long, and the blade or leaf itself 3 feet long. Next to, and surrounding the main body of palms, about 100 feet wide of smaller palms, which were growing at only 2 feet from each other. The stems were but 1 foot high, they bore the same number of leaves (six) as the other plants, but, unlike them, half the number of leaves were bad. The leaves and

their stems were each 1 foot shorter than those on the larger plants, and the pelicles were much more slender. Outside of this belt, and on the extreme margin of the plantation, there was a second belt which, however, was very narrow. It consisted of only three rows of palms, the plants being very close together, only 1 foot 4 inches apart. None of the leaves on this belt appeared good enough for fan manufacture.

The inner belt of plants was intended, by reason of thicker planting, to serve as a screen to protect the main plantation from the damaging effects of winds, while at the same time it affords finer leaves for smaller fans. The marginal and closely planted belt was placed on the river bank to serve as a fence to keep intruders out of the plantation. For this purpose the palm, while in a young state, and when planted together, is well adapted; the spines on the pelioles presenting a barrier sufficiently offensive to the bare, stockingless, and shoeless legs and feet of the Chinese coolie. The long, straight vistas, the regularity of the planting, and the canopy of the verdant leaves overhead, produce on the visitor a delightful impression which is worth travelling some distance to experience.

Other plantations contained palms of all ages. Some had trees upwards of a hundred years old, according to the assertions of natives, but these plantations always contained trees of mixed ages, young plants having been constantly added to take the place of older ones as they died out, or were blown down by winds. The old trees were always of a very stunted appearance, a condition which would naturally ensue from the continued lopping of its leaves. A parasitical fungus or lichen covered these old trunks, and gave them the appearance of having been whitewashed. The tallest trees seen were only about twelve feet high, but they were said to be upwards of a hundred years old. The leaves on these old trees are larger and stouter than those on young plants, and the stems of the leaves are only about a foot long. The palm begins to yield leaves suitable for fans when it is about six years old. The first cutting of leaves takes place early in the year, and the leaves which are somewhat damaged by the winterly winds and consequently of inferior quality, are used for thatch in the construction of the "matsheds" which are to extensively used for temporary purposes in China.

Leaves for fan making are obtained in April, one, two, or three leaves being taken from each plant, and the process is continued each month until November, when, I was informed, cutting is discontinued for a few months. The leaves are taken from the plantations to a clear space covered with short grass turf. Here each leaf has a thin piece of bamboo placed across the blade where it is joined on the stem. Each end of the bamboo is secured in its place by the loose end of a segment of the leaf being dexterously bound round it. The bamboo prevents the leaf curling up while it is drying. The leaves are then laid out singly on the turf to dry in the sun, and collected and stacked at night. The process is continued daily until the leaves are quite dry, when they are either sent off direct to the town to be made into fans, or they are stacked for a time until the manufacturers are ready to receive them."

The manufactory of the fans is carried on chiefly in the town of San Ui, but there are also some establishments in the country where this is done. The dried leaves are subjected to a process of blanching by means of sulphur. They are then straightened and rendered shapely by being held and manipulated over a charcoal fire. The operator, as he finishes the fans, places them one by one on each other, making a heap on the floor; the heap is firmly pressed down by the weight of the operator, who stands on a board placed on top of the heap while he is working at succeeding fans. When a heap of twenty or thirty fans have been thus treated, they are removed, and another series is begun. The next process is sewing on the bindings at the edge of the fans, this is done by women and children, chiefly at their own homes, and the fans returned, when finished, to the manufacturer. The more expensive fitting of horn and bamboo handles is done at Canton. The portion of the stalk which is not required as a handle for the fan is not wasted; it is composed of a fibrous material that is utilised in making short lengths of rope used as slings to suspend baskets from carrying poles. Around the stem, as bases of the leaf stalks, there is a quantity of fibrous substance, somewhat resembling coir fibre; this is carefully collected, and also used for making ropes.

General Notes.

Cadiz Naval Exhibition.—This Exhibition, which includes fishing and naval appliances, all kinds of life-saving apparatus, machinery, pictures, and Moorish and other curiosities, was opened on the 15th inst., by Senor Moret, Minister for Foreign Affairs.

Metrical System in Russia.—The Russian Ministry of France has been making inquiries as to the possibility of the metrical system of weights and measures being adopted in Russia. The Warsaw Exchange has expressed itself favourably as to the contemplated reform, the relations between Poland and other nations where the system is in force being sufficiently close to allow of the contingent charge being effected without any serious inconvenience. A period of six years has been proposed for the introduction of the new system, after which time its use would be obligatory.

Journal of the Society of Arts.

No. 1,815. Vol. XXXV.

FRIDAY, SEPTEMBER 2, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MOTORS FOR ELECTRIC LIGHTING.

Four Gold Medals and Four Silver Medals are offered by the Council of the Society of Arts for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows:—

1. The motors will be divided into two classes, *A* and *B*. Two gold and two silver medals will be allotted to each class.

(A.) Motors in which the working agent also produced.—Steam and gas.

(B.) Motors in which the working agent must be produced.—Steam, gas, hydraulic, and air.

2. Each class will be sub-divided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p. Each motor will be worked at or about the power at which it is entered.

[The horse-power herein mentioned is equivalent to 33,000 lbs. raised one foot high in one minute, as measured on the brake.]

3. For four-horse power and under, the entrance fee will be £10; above four-horse power, the entrance fee will be £2 10s. per h.p. The fees to be paid on entry.

4. No competition will be held unless ten motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The Council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the Regulations of the Royal Agricultural Society.

8. The points of merit considered of the greatest importance are—

a. Regularity of speed under varying loads.
b. Regularity of speed during the various parts of one revolution, or one cycle of revolutions.
c. Power of automatically varying speed to suit arc lights.
d. Noiselessness.
e. First cost.
f. Cost of running.
g. Cost of maintenance.

9. The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal of the Society of Arts.* They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the Society, all claims in respect of damage (if any) resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the arrangements or in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June, 1888. Entries must be sent in by the 21st December, 1887.

13. All costs of fitting up and working the motors must be borne by the exhibitor. The Society will provide the brakes, indicators and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

Fuller particulars will be found in the number of the *Journal* for July 29th.

Forms of entry can now be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE DISEASES OF PLANTS, WITH SPECIAL REGARD TO AGRICULTURE AND FORESTRY.

By J. L. W. Thudichum, M.D., F.R.C.P. Lond.

Lecture I.—Delivered January 24th, 1887.

Diseases of plants are caused by three classes of causes:—(1) Chemical and physical; (2) parasitism of plants; (3) parasitism of animals. Of these, the second class are the most important, and therefore treated of in the first instance. The vastness of the subject, as compared with the time allowed for its treatment, will justify my appeal for your patience and attention. I shall bring before you but few illustrations, for many would confuse. The magic microscope cannot easily be employed for demonstration, because the rays destroy the delicate objects by heating them to destruction. I shall therefore demonstrate the principal anatomical facts by drawings on an enlarged scale.

History of Development of Knowledge.

The recognition that the principal diseases of plants might stand in connection with, or be the direct consequences of, the parasitic invasion of fungi, was expressed distinctly for the first time by Persoon, in his "Synopsis Method. Fungorum," published in 1801. He declared that the so-called rusts on plants were fungi. This knowledge was more perfectly elaborated by Benedict Prévost, in his "Mem. sur la cause immediate de la Carie ou Charbon des Blés," Paris, 1807, 4°, 3 plates (plate 3, half on black ground, very beautiful). He found the spores, made them grow on water (June, 1804), and announced that the plant was the cause of the disease. But as the remainder of the life history of these fungi was not known (Persoon, in 1818, allowed some to arise from spores, some by spontaneous generation), the new knowledge was not allowed, or was denied. Even those who allowed the growths on sick plants to be fungi, believed their presence had to be explained as the result of a previously existing illness. Some went so far in this mode of explaining imperfect observation, that they made the hypothesis of the degeneration of the sick plant tissue into tissue of the parasitic fungi; in other words, they assumed the spontaneous generation of fungi out of decaying or decayed vegetable tissue. In the work of Franz Unger (Vienna), "The Exanthemas of Plants," published in 1833, and in that of Franz Julius Meyen, "Pathology of Plants," published in 1841, these erroneous doctrines were still taught. The full proof that fungi are not only the accompaniments but the actual causes of the principal diseases of plants, was most elaborately furnished by the brothers Tulasne, about 1850, and further expanded by Alex. Brown, Kühn, and De Bary; in this country by Berkeley and Cooke. The brothers Tulasne published a series of remarkable essays and works on the most difficult fungi, which were illustrated by beautiful pictorial representations, viz.:—"History of Development of Ergot of Rye," 1855; "Discovery of several Organs in Peronospora," before 1861. The entire science of mycology seemed to undergo a reformation by the publication of their "Selecta Fungorum Carpologia," 3 vols., 1861 to 1865.

In connection with the history of the recognition of the vito-parasitic nature of fungi, it must be pointed out that the diagnosis of the silkworm disease, muscardine, was already made by Bassi, in 1840, and further elucidated by Audouin. Cessati made researches on the fungi of the muscardine in 1852, and Cohn's remarkable research on the mould-fungus *pilobulus* dates from the same time.

Amongst the manuals and monographs describing the diseases of plants encyclopædically, the latest are by Sorauer and by B. Frank, 1881. These works are excellent in many respects, but like most conscientiously written manuals, are better guides to the study of original literature than sources of final information.

A very excellent work on "British Fungi" is that by Berkeley (1860), though in it the particular fungi which cause diseases are very summarily treated. A most instructive work, and one which has the rare quality of being readable and entertaining, is the work by M. C. Cooke, with a preface by Berkeley, "Fungi, their Nature, Influence, and Use," London, 1875. The same author has also published a "Handbook of British Fungi," 1871, 2 vols., which is a systematic treatise, illustrated by woodcuts in the text, and by two volumes of beautiful plates representing the Hymenomy-

cetes. I am not aware of any English monograph on the diseases of plants.

In the prosecution of the study of life history of fungi, *i.e.*, mycology, it is above all things necessary to observe the method already well inculcated by Prévost. The low fungi have not only to be found out in their natural haunts, but they have to be passed through all stages of their natural development by so-called cultivation. By the careful prosecution of this method of research, it has been shown that fungi penetrate into the entirely healthy tissue of higher plants, grow within them, and arrive again at fructification on the outside of their host before its life is extinguished by the parasitism. The parasite causes the host to be sick, hinders its nutrition, and consequently its growth, and frequently makes an end of it altogether. Thus the saprophytes, which have no power over living tissue, but devour anything bereft of life, join in the process of destruction, and the previously highly developed material becomes a magma of putrefactive products mixed with the saprophytes in many stages of development.

The fungi show, yet in a higher degree than the algæ, a peculiarity of propagation, namely, that many non-sexually produced generations may intervene between rarer sexually reared generations. In algæ such alternations take place within the same nutritive medium, but as regards fungi, it was found that each particular form prefers or absolutely requires a particular kind of substratum, in which alone it will come to its complete development.

Since 1861 the sexual organs of the peronosporeœ were frequently observed, and in 1863, De Bary announced that the entire fruit body or seed capsule of an *ascomycete* is the product of a sexual act, which is somehow or other performed by the threads of the mycelium itself.

Some prominent botanists maintain that, as a result of the algological and mycological studies of the last twenty years, the two classes of algæ and fungi, which hitherto have been carefully separated from each other, would have to be united into a new class, in which algæ and fungi appear only as habitual forms, the one of the other. So that an alga would be the submerged living form of a fungus, which itself would live in air; while some fungi could also, like their algaform, live in suitable liquids.

Not less remarkable were the results of inquiries concerning the lichens. F. W. Wallroth, who was born on the Harz mountains, and died as physician to the town of Nordhausen in 1857, had discovered that lichens contained two principal elements of structure, namely, the hyphæ-tissue of the thallus, which was like a fungus, and within that green cells, which were termed gonidia. About 1868, Schwendener discovered that these gonidia are genuine algæ, the hyphæ-bodies of the lichens genuine fungi, and that therefore the lichens have to be considered as a division of the ascomycetes, which have this peculiarity, that they surround the plants upon and from which they draw their subsistence, entirely receive them in the interior of their tissue, and use them as an organ. This kind of parasitism has, by De Bary, been termed *symbiosis*.

I will now give a short botanical definition of fungi, after Hoffmann, modified to meet the new discoveries made since 1847.

Definition of Fungi.

Fungi are plants which live in or upon either healthy living higher plants or animals, or on or within the dead and decomposing tissues of plants or animals. They are composed of cells, which are for the most part not of green colour (*achlorophyta*), and propagate by germinal cells (*sporœ*, *sporidia*). These latter are mostly simple, without any covering, or they repose on threadlike cells (*hyphœ*), or are enclosed in bags (*asci*), which are themselves again enclosed in bladder-like capsules (*peridia*); these latter are filled with gelatinous matter, or with a very fine tissue (*capillitium*); or the asci are united in a particular membranous layer. Linné described fungi in the following melancholy sentence:—"Nomades, denudati, autumnales, fugaces, voraces, qui flora reducente, plantes colligunt, earum quisquilias sordesque." The actual nutriparous organ of the fungi is the combination of hyphæ, termed *mycelium*, also by comparison with grass-turf, fungus-turf, a *simile* which is most commonly realised, though on a small scale only, by the mould-fungi.

As the parasitic fungi are regenerated by spores, and as these spores can be transferred through the air from the plants on which they have been formed to new plants, on which they settle, and on or into which they grow, these spores constitute what in animal pathology is termed the contagium. Like animal contagia, the spores of parasitic plants are able to stand the test of experiment; when

transferred artificially upon healthy plants they reproduce the entire series of stages of evolution of the particular fungus of which they are the seed.

Spores.

The spores are microscopic objects, but when collected in masses appear to the eye as a fine dust, such as can be beaten out of the bovist on a dry hot autumn day, on the downs. Spores are mostly very small; thus the uredo of grain has spores which are 0·007 to 0·008 mm. in diameter, one cubic millimetre contains 7,000 of these spores. The spores of the fungus of the potato disease have a diameter of about 0·027 mm., and belong to the largest, while those of uredo belong to the smallest sized spores.

The spores are cells surrounded by a membrane; the contents are protoplasma, with much oil in visible droplets. The membrane consists of two layers, an outer, stronger, frequently coloured one, the *episporium*, and the inner, thinner, colourless *endosporium*. When the spore grows, for which moisture and warmth are adjuvants, it forms a hollow projection, a kind of vegetable proboscis called *ascus*, which, starting from the endosporium, penetrates the episporium, and then proceeds through the stage of *hyphœ* to that of their multiplication, the *mycelium*. The spores of some parasitic fungi are moving, or zoospores, *i.e.*, plasmatic cells not surrounded by a membrane, and hence termed nude, which by fine threads, *cilia*, are put into a rotating movement; these live only in and are distributed by water, whereas the spores, which are surrounded by a hard membrane, pass into a state of rest, lasting spores, in which they can bear drought, heat and cold, and be distributed by the atmosphere over great areas.

Modes in which Plants are Attacked by Parasitic Fungi.

We must first distinguish between parasites which live in or upon parts of plants growing above ground, and such as live in or upon parts of plants growing below ground; some parasites infest the parts of plants growing above as well as in the earth. Now the parts of vegetables which grow in the air are mostly infected through the air by spores which arrive upon the healthy parts. Here they must be fixed by moisture, by the presence of glutinous exudations, or mechanical advantages. Few spores penetrate directly with their proper body into the tissue of the host; such are certain ciliated moving spores, which bore into and through epidermic cells, or into the cells of algæ, just as the young trichinæ bore through the tissues of the intestinal canal of man and vertebrate animals, absorb nutriment, increase in size, and starve or kill the cell in which they have settled. The embryos of many tapeworms in a similar manner, and frequently with the aid of deciduous boring teeth, penetrate the tissues of their hosts, and migrate to the place destined for their further development. Most other spores, even of the gyrating kind, and all resting spores, do not themselves penetrate into the tissue of the host, but send a growing proboscis, the ascus of germination, gradually, and by the accumulating mechanical force of growth, into the tissue of the host; this penetration takes place through epidermic cells, the ascus enters by mechanical force, just as the sting of the gnat, the flea, the bug, enters the skin of man or animals; or if the host be supplied with spiracles, or air-holes, as most phanerogams are, particularly on the underside of their leaves, the spore sprout enters the respiratory passage, and from the footing thus gained, grows into the tissues which offer least resistance, or are most congenial to its nutrition. It has seemed to me that with the mechanical action of entry there is mostly combined a chemical effect, perhaps a fermentative action, exercised by the parasite, by means of which the substance of the cell of the host is either weakened or fluidified; but when considered in close detail, the penetration of the ascus into and through cells is as difficult to explain as the stings of insects such as those already alluded to. For the manner in which the known resistance is overcome is at present withdrawn from observation.

Like animal parasites, those of plants either make selection of particular organs, remain confined to the locality where they have entered, or spread more or less to the adjacent parts, or infest the entire organism. Thus there are animal parasites which grow in the muscles mainly, although they were born and bred in the intestinal canal, where also they live as sexually mature beings, the trichinæ. Some of the tapeworms which, when full grown, live in the intestine of the dog, have an early stage of development as bladderworms in the brain of the sheep, where they multiply asexually, and these cannot develop in any other tissue except the brain. So some vegetable parasites affect stamina only, or leaves of flowers, or seeds, or leaves, or bulbs, and do

not spread or penetrate elsewhere, while others penetrate into a certain part of the plant, which they leave almost unaffected, and grow towards a distant part, where they become developed and form the organs of reproduction. Of this kind are the *uredos*, which may enter a plant at an early stage of its development, and come to maturity in a part which, when they entered, was not yet in existence. In all these facts the refined and insidious nature of the parasitic creation shows itself so unmistakeably, that it has been termed "the devil's creation."

Selection of the Host.—As most animal parasites have their particular hosts, apart from which they cannot live or complete their cycle of evolution, so many vegetable parasites are confined to particular hosts, and perish if they are withheld from them. Such an alternation of generation, as it is termed, as exists amongst animal parasites, of which many require two individuals of the same species in succession, does also appear to exist in the vegetable series; for there are so-called polymorphous heterœcic fungi, who require two individuals of different species in succession for complete development. Many *entozoa*, *e.g.*, complete their course of life by passing a part of it in a herbivorous, another part in a carnivorous host, which latter acquired the parasite by devouring the former. In plants such a double residence, heterœcia, is also known, and requires two different conditions of the plant, of which each must have its peculiar spores. Vegetable parasites may live upon or in species which are closely related to each other; endophytes are more confined in this respect than epiphytes; and of course epiphytes which only settle on the surface of hosts, and live at least in part on their juices, have the widest area of distribution.

Several specific effects which Parasitic Fungi produce upon their hosts.—Some plants do not seem to be much affected by their parasitic guests, so that the case of some *chytridiaceæ* and *saprolegniaceæ* living on algæ in the water, although representing undoubtedly, a parasitism cannot be called a pathological case, except in the sense of its being a mechanical anomaly. A more common effect upon plant tissues is, that the contents of the cells are absorbed by the suckers of the parasite, starch corpuscles disappear, the balls of chlorophyll fall to pieces and lose their colour, and the protoplasm contracts and disappears; at last the cell contracts, collapses, and dies. The part of the plant in which this process is in course of progress or completed, assumes a yellow or brown colour, shrivels when dry, but, under the influence of moisture, enters upon a process of active putrefaction. In more active processes the parasitic fungi destroy the cell walls as well as their contents, so that the tissue of the host disappears entirely in the invaded part, and the parasite takes its place. In these cases we have to think not only of mechanical disintegration, but also of fermentative solution.

The parasite may also exercise an irritative action so as to engender excessive nutrition, and this may lead to the thickening of tissues, hypertrophy, or to many and large tumours, as in the *anthracosis* of the vine. These enlargements, when they are more detached from the plant, and seem to have an individual existence of their own, are termed fungus-galls, or *mycocecidia*. This condition produces very strange changes in entire branches, or entire trees, or groups of trees. Thus in Hyde-park and Kensington-gardens there are a number of elm trees, and in and around London I have seen a great number of birch trees, chronically affected. Such plants are always crippled as regards foliage, inflorescence, and frutescence, and although unnumbered little sprouts may form and give rise to the phenomenon sometimes called "witch broom," the trees do not grow well, and are either always thinly foliaged or shed their leaves early.

We will now consider one of the simplest cases of vegetable parasitism, namely, that caused by *chytridiaceæ* upon water plants, algæ. The plants so-called consist of a single microscopic cell. They settle either upon aquatic plants or low animals, and frequently affect only one cell of their host, this may become increased or exhausted and die. Fig. 1 (p. 898) represents one of these simple cases of parasitism after Alex. Brown (*Chytridium globosum* upon *Pedagonium fonticola*). Here the parasites are globular, as the name indicates. In Fig. 2 (p. 898), representing *Chytridium olla*, so called because pot-shaped, the parasites show roots, haustoria, which they send into the cell containing a sporangium of *œdogonium rivulare*. One pot is empty, the other just discharges spores, with a single cilium each. These spores settle again directly upon cells of the alga, grow haustoria, destroy the contents, reproduce themselves, and so on. These examples are, in the main, epiphytes, as no part of their structure, except the

haustoria, enters the host. There are more than twenty of these epiphyte *chytridiaceæ* known. One lives upon the celebrated microscopic object, the *Volvox globator.*

Fig. 1.

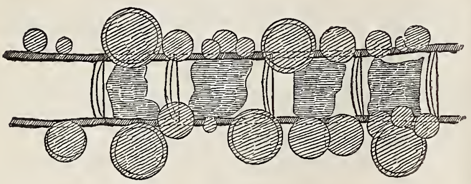
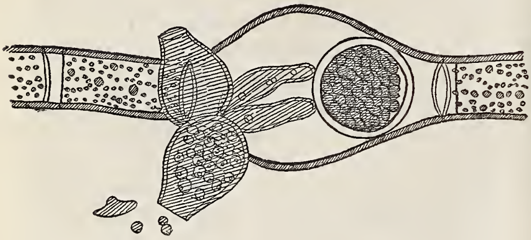


Fig. 2.



The *Endophytic Aquatic Chytridiaceæ* are also simple, but their spores enter the cells of the host, and grow there to maturity; then they send a special branch through their hospitable cell, and discharge the spores into the open water, whereupon both the host-cell and the endophyte die. These fungi live upon sea algæ, and were formerly believed to be organs of fructification of these hosts themselves. There are several (six) genera and many species known, but we have not time to occupy ourselves further with these, in themselves, highly interesting marine objects.

A third class of *Chytridiaceæ* lives parasitically in the epidermis of phanerogamous plants; these also form ciliated spores, by means of which the disease is spread. This process takes place with the aid of moisture or surface water, so that contiguous plants only become infected, or keep each other infected; the spores are not distributed through the air by by wind. All known members of this division form the genus *synchytrium*, which is divided into three sub-genera, comprising about a dozen species. One of them lives on the dandelion, another on the dog violet; none is found, as far as I know, on cultivated plants or forest trees.

The *Saprolegniaceæ* are a little higher organised than the *Chytridiaceæ*, but only a small number of them are parasitic; the greater number are living on vegetable and animal matter already dead and in a state of decomposition. The parasitic varieties are mostly endophytes. They produce in the host a diseased state, which shows itself as atrophy and death. There are are seven genera known, with a number of species each.

We come now to the genus of *Peronosporeæ*, which includes the dreaded fungus of the potato disease, the *botrytis* or *peronospora*, or *Phytophtora* (*devastans*) *infestans*, the fungus of the potato murrain, as it has been termed by Berkeley. This fungus was discovered upon sick potato plants, in 1845, by Mlle. Libert and M. Montagne contemporaneously, and received by the former the name of *Botrytis devastratrix*, by the latter, *Botrytis infestans.* Since that period it has been investigated by a great number of botanists, agriculturists, and microscopists One of the most interesting monographs on it, as well as other parasitic fungi—*e.g.*, those of the sugar-yielding beet plant and those of the vine—has the celebrated French *savant*, M. Payen, for its author. Another, in German, was written by De Bary, now of Strasburg University. In this country, Berkeley and Smith published important observations in the *Gardeners' Chronicle* of 1875 and 1876. The actual experimental infection of healthy potatoes with spores of the fungus was first successfully carried out by Speerschneider in 1867 (*Botan. Zeitg.*, 1867, p. 121), and in America also the fungus and its congeners have been studied by Farlow and others, 1876

The disease of the potato, to which this fungus gives rise, was first observed in North America, where, in 1843 and 1844, it caused much destruction. It then showed itself epidemically in Europe in the cold and wet summer of 1845, and lasted with great severity during five years. It has never disappeared entirely since, and affects most potato-fields more or less in wet years, least when the season is dry and warm, and the potato plants have a rapid development. The beginning of the disease upon the plant shows itself by degeneration of the herb. The leaves exhibit brown spots here and there, which become gradually larger, these spots shrivel, dry, and die. On looking on the underside of such a leaf, one sees the dead part surrounded by a discoloured zone, the outer margin of which is covered with a whitish thin film like mildew; this fine mould consists of a great number of stalks of the fungus, carrying conidia; and on examination it is found that all these fungus

stalks have grown out of the epidermis of the leaf. If this mildew is not visible to the bare eye, which is the case in dry, warm weather, it can be produced by placing the leaf for a few hours into a warm, moist chamber. The progress of the disease upon a potato plant shows itself by the multiplication of spots, the dying of leaves, the decay of the stalks, so that after a short time the entire plant above ground is dead, and discoloured, or decayed and dried. The decay of the stalks causes necessarily the infection of the tubers. Not only do the tubers not attain their natural size and development, but they become infected at the place of the insertion of the stalks, and the infection progresses from the tubers attached to stalks to those further removed. In not a few cases, in wet years, do the tubers already in the ground become putrid; in drier years they are only slightly infected, and hardly exhibit signs of the disease until they are for some time in the cellar. Here, if the cellars are close, the infected potatoes become rapidly putrid, and infect others by contact; or if the cellars be dry, and well-ventilated, the affected potatoes shrivel up to a dead, frangible, dry matter; in any case, the potato is nearly useless for food or manufacture of starch, or spirit production. These two modes of putrefaction are distinguished as the wet and dry rot respectively. On such potatoes are found many varieties of mould fungi, which are saprophytes, and have nothing to do with the original disease; they only feed upon the already killed and decayed potato. Amongst them is a crimson red fungus, termed *Acrostalagmus cinnabarinus* (Corda).

The infesting fungus can be found by the microscope in every infected part of the plant, in the entire periphery of each brown spot. It grows as a mycelium of many threads in the mesophyll; the mycelium consists of single hyphæ, formed of single elongated cells, which not rarely send out branches. The tissue which is only just invaded by the fungus exhibits its natural appearance, but when the fungus has penetrated it, it loses its plumpness, becomes flabby, sinks, and dies; the chlorophyll becomes brown, and the rest of the decomposition is according to accident. In the dead tissue the fungus also is dead; this shows that it is a parasitic endophyte, which requires a living plant for its residence, and is not a saprophyte, which lives upon the decomposition products of dead vegetable matter. Now as during its eccentric growth the fungus constantly sends branches through the air-holes (spiracles) of the leaves into the air, which carry conidia ready to propagate the fungus either in the immediate proximity, or at any distance (Fig. 3), and as the points

FIG. 3.

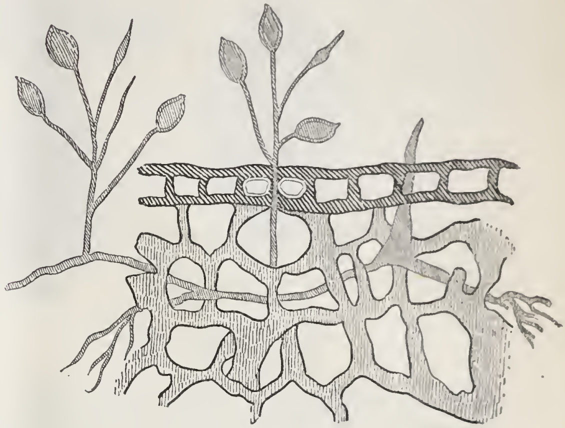
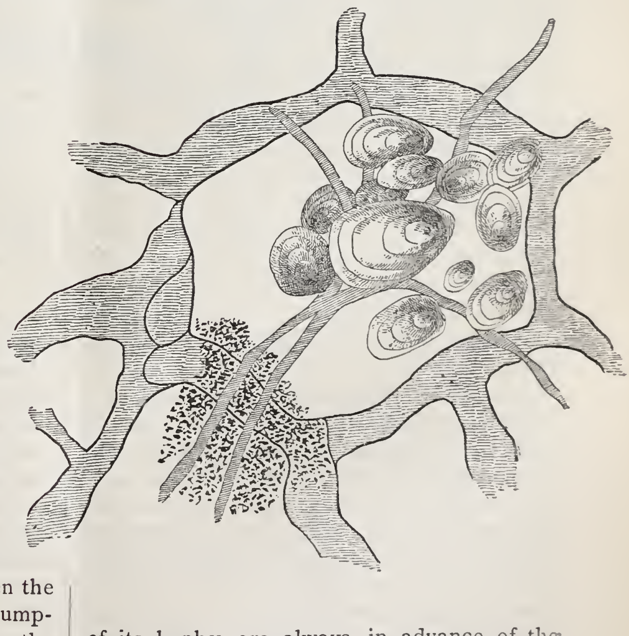


FIG. 4.

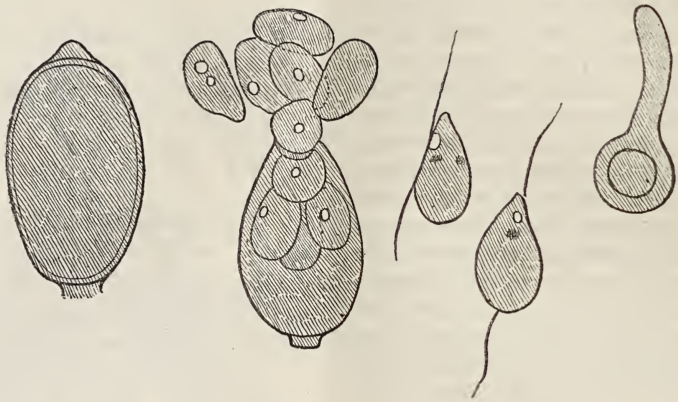


of its hyphæ are always in advance of the decay, piercing the healthy tissue, a plant once invaded can never get rid of the parasite. It can only, by the aid of fine weather and quick growth, make a more or less successful attempt against total destruction.

The conidia when shed, either grow directly

into hyphæ or undergo a transformation by which they become *sporangia*; that is to say, they form in their interior a number of spores, from nine to sixteen, which leave the capsule by the top, where they have a lid, and now become zoospores. These latter now move about singly, by means of two cilia each, which are attached at both ends. After about half-an-hour of such intermittent gyration, the zoospores come to rest, shed the cilia, and

Fig. 5.



become resting spores. If now opportunity and moisture be present, the resting spore at once grows a germinal hypha, or ascus, and in a few hours is inside its appointed host, the potato plant, and begins its ravages.

The hyphæ of the mycelium are also found in the sick potatoes; not only in the already decaying and discoloured parts, but also in the adjacent apparently yet healthy tissue. As on the leaves, the mycelia in the tubers may be made to bear conidia, by placing them in slices in a warm moist chamber, where the conidia-sprouts will soon rise above the surface. The diagram (Fig. 4, p. 899) shows a cell of a tuber, permeated by fungus threads; on one side the starch cells are already absorbed, and the cellulose is beginning to disintegrate.

To artificially infect either a potato plant or a tuber, it is only necessary to place upon its leaves, or the peel of the tubers, some conidia of the phytophtora, and leave them in a moist warm chamber. The conidia or spores, as the case may be, will then penetrate the epidermis of the leaf or the cork-rind of the tuber, and the rest will follow as it has been described in the foregoing.

If the spores do not quickly come in contact with a host upon which they can grow, they perish; and it is highly probable that no spores whatsoever survive the winter in the free state. As yet it is not known whether or not this fungus produces lasting spores. Some inquirers maintain to have found such, others deny that the bodies found were seeds of the phytophtora, the latter alleging that they are oospores of a *saprolegniacea*, which they term *Pythium vexans* (De Bary), or *Pythium autumnale* (Sadebeck). These discussions are part of the greatest difficulty in all inquiries of this kind, and I only allude to them without intending to carry on a judicial discussion of the controversy.

Now as the seeds perish in air and soil, it is clear that the parasite survives the winter by means of the protection it receives in the infected potato only. If such a potato, not entirely decayed (Fig. 6, p. 901) be planted, it will grow, and the fungus will ascend with and in the sprout, and as soon as leaves are formed, will send conidium-bearers through the spiracles, and propagate its kind upon healthy plants all round. But it is also certain that undoubtedly sick potatoes grow herb which is not infected, and although such a potato cannot well act as the intermediary for descending sap to reach the new tubers forming out of roots, and may communicate the disease to one or other of the new tubers, it has not the same fatal effect as an invasion of the herb, which not only destroys the herb itself, but prevents the underground organs from attaining a proper size and development.

The phytophtora does not live parasitically upon any other genus of plants except the one termed by botanists *solanum*, and, it is stated, only upon such as are, like the species *tuberosum*, indigenous to its natural home,

South or Central America. It is hence inferred that the phytophtora also came from the American home of the potato. The fungus has been observed upon some *scrofularineæ*, one from Australia, and one from Chile, but as these are rare cultivated plants, the occurrence is not of much importance.

We now arrive at a stage of our subject at which it is necessary to take a wider view of diseases to which the potato as a plant, as well as a tuber, considered as a reserve food for man and animals, is liable. When important discoveries like that of the phytophtora are made, there is always a danger that other only less important but simple phenomena, produced by different agents, are lost sight of, because they too are affiliated to the now known cause. In this manner sundry causes which produce decomposition and death in potatoes are liable to be confounded with the result of the phytophtora. These we shall now have to distinguish with the necessary brevity.

Whereas the potatoes in the course of dry rot exhibit saprophytes on the surface, those involved in the process of wet rot exhibit not only myxomycetes, but also bacteria in their substance. Now, experiment shows that these latter organisms are the cause of the rapid decay which then ensues. The saprophytes may be placed upon a section of healthy potato without producing much or any harm; the potato throws out a layer of cork on or at a little distance within the section surface. It heals, as it were, and the healthy substance inside of the new limitary membrane is no

FIG. 6.

longer liable to be affected by the saprophytes; but when bacteria are placed upon such a cut surface, and moisture is present, these organisms multiply and destroy the potato the quicker, the greater is the advantage of warmth and moisture. The mere withdrawal of moisture will arrest the bacterial decay, and cause it to pass into the more slow process of dry rot. The greatest ravages are produced in potatoes infected by the phytophtera, the bacteria, and saprophytes combined. By this combination, a healthy potato may be transformed into a shapeless discoloured lump of putrid matter in the course of three days.

Botanists and vegetable pathologists, no less than animal pathologists, have frequently stated their impression that the pathogenetic fungi and microzymes act upon the healthy tissue in a manner as if they secreted a poison, by which the vitality of the tissue is destroyed, so to say, dynamically, as distinguished from destruction by mere mechanical means. Thus in the great epidemic of anthrax, or splenic fever, in which so many stags in the royal park near Berlin were destroyed, it was not rarely observed that the number of bacilli of the anthrax disease were so small that the mechanical effects produced thereby appeared to the observer insufficient to explain the death of the relative subjects. Our foremost inquirers—*e.g.*, Koch, of Berlin—hold that the effect of the microzymes of cholera which have been found only in the intestinal canal, and not in either blood, lymph, or tissues, can only be explained by the assumption that they

produce or secrete a poison which is absorbed, and acts upon central vital parts. A similar toxic action must be thought to be probable in vegetable parasitisms which end with the destruction of the host. Some ascribe already to the phytophtora itself a weakening action upon the permeated tissue, and it is tissue thus weakened which easily falls a prey to the bacteria alluded to, the weakened tissue being unable to form a limitary membrane by which, as we have seen, saprophytes and also bacteria are excluded.

The bacteria in the potato have manifold effects; they decompose the cellulose and the protoplasm to such an extent that the starch granules float in a shapeless mass with a putrid odour, which odour is a mixture of that of butyric acid with other undefined odours. The bacteria—and we omit the consideration for the present of the number of species which may be present—further attack and destroy the starch granules, always supposing the presence of a degree of moisture sufficient for the prospering of the bacteria. The bacteria, like the myxomycetes, verticillium, hypomyces, and nectria solani (the most common saprophytes of dying potatoes), are not capable, of their own strength, of piercing the cork-rind of the potato, but penetrate by the door of wounds or slight abrasions, if the wound or abrasion be moist; if it be dry, they have no more power over the potato than the saprophytes. Both penetrate easily with the phytophtora, or through the passages which it ceaselessly bores through the potato tissue in the endeavour to sow its conidia-carriers into the atmosphere.

This common participation of bacteria in the putrefaction of diseased potatoes was first pointed out by Hallier in 1875, and further studied by Reinke and Berthold in 1879. These observers found the *Bacillus subtilis* of Cohn, which would explain the odour of butyric acid found in diseased potatoes. The bacillus was present in the quiescent and moving form, and surrounded by micrococci, which they believe to stand in relation to the bacillus. Besides that, they found a bacterium called by them *Bacterium navicula*, from its similarity in shape to a shuttle; this had a protoplasm which was frequently coloured blue by iodine, like the *leptothrix buccalis* from the human mouth. Besides these, there was a colourless sarcina, named *Sarcina solani*, in the usual square packets, as well as single micrococcus forms, and a zooglœa, species undefined; *bacterium termo* also intervened now and then. So that after these developments, the decay of potatoes following upon the invasion of the phytophtora appears not to be so direct a consequence of the parasitism pure and simple, as (in consequence of limited observation) it might seem.

We now arrive at the practical question regarding the means of curing and preventing the potato disease caused by the phytophtora.

Almost any disease, be it of man, animals, or plants, loses its greatest power for evil, as well as the terror and apprehension it causes in the human mind, as soon as its nature is fully understood. So I have no doubt that the potato disease by the phytophtora lost its sharp edge in the five years which followed upon 1845, gradually owing to the measures which were taken for its contravention. If, nevertheless, it has not disappeared, we must investigate not only what has been done for its extinction, but particularly what has been left undone. In this investigation I shall rely mainly upon my own observation, leaving you to make reflections which every thinking person can institute for himself.

Potato growers have been enjoined to plant only healthy potatoes, but I have known persons select partially sick potatoes, cut away the discoloured part, and plant the rest. They knew that healthy potatoes, divided in pieces, are good for planting, but they ignored the fact that a healthy-looking piece of a sick potato may, perhaps necessarily does, contain the fungus. You can guess the result.

Again, potato growers have been enjoined to pick all sick potatoes out of the healthy, keep the latter, and destroy the former. But what do agriculturists do with the sick potatoes? I was in Hampshire only last autumn, and in walking over a potato field which had just borne a crop, I picked up, for a mineralogical and geological purpose, sundry pieces of rounded stone; at once I perceived amongst them diseased potatoes; I made selections and examined them well; they were infected by the phytophtora. The agriculturist had made the selection, carried the apparently healthy potato home, but had left the diseased potato on the field. Now I am quite ready to believe that most of these potatoes with their parasites will perish in a sharp frost, but it is equally certain that in a mild winter they will survive, sprout in spring, as weeds in any other crop, and the rest you may surmise. Similarly, I have seen farmers in a large way of business causing their cellars full of potatoes to be overhauled, and the sick ones to be

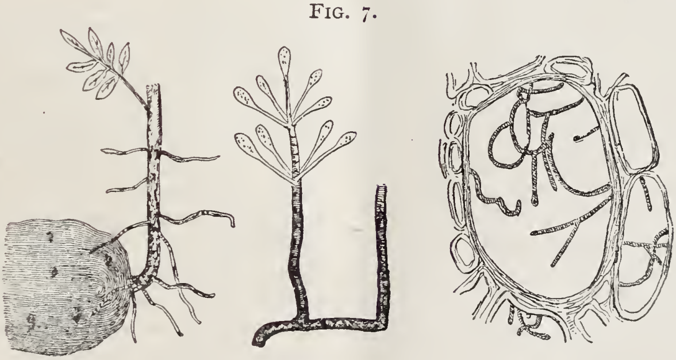
picked out, and used for the food of animals, or for the distillery. But those which were advanced to the stage of putrefaction, and judged to be unsuitable for food or fermentation, were thrown upon the dungheap. Now think of the possible consequences of such an injudicious practice. The potatoes should at least have been boiled before being thrown upon the dungheap; or if they were not worth the boiling, should, like an ox dead from anthrax, have been thrown into a deep pit, covered with caustic lime, and buried for ever.

When the infection is on your growing crop, you can do nothing to save your own crop. The cutting of the herb, not followed by its destruction by heat, might increase the evil. But it might be worth while to destroy all affected herb, and all affected tubers as well, as a matter of public policy, and allow to every suffering agriculturist half the value of the possible or probable crop. I believe that if such a measure were carried out upon all potato fields as that which has been directed against the cattle plague, the potato plague would be exterminated as certainly as the cattle plague was exterminated.

We have now shortly to consider a parasitic disease of the potato, which is different from that caused by the phytophtora, but claims historical interest, inasmuch as it was epidemic on the fields of England, France, and Germany during the last third of the last century, and continues now and then to break out locally with great severity.

We pass over the many conflicts of authors on what is popularly called the "frizzle sickness," and follow Hallier and Reinke and Berthold in its definition. The disease consists essentially in the presence in the potato plant of an endophytic fungus, *Verticillium albo-atrum.* It grows in the tissue of the tuber and stem and leaves like the phytophtora, but has a different structure and fructification; it particularly affects that part of the stalk which is underground, and colours it and the adjacent roots black. This black colour is due to certain portions of the

Fig. 7.



fungus itself, namely, to the hyphæ below the fructification, and to the torula form of spores. Upon the details of structure, growth, and propagation, however interesting they are to the fungologist, we cannot here enter. The disease is propagated by spores from one potato bush to another; the fungus permeates gradually the entire plant; the leaves shrivel up and curl, at first without drying, at last becoming yellow and dead. In this manner all potato plants on thousands of acres of land may be dead already in the middle of August. The tubers are apparently not much affected, though of course they do not attain their normal size. But the fungus has penetrated to their interior, and here hybernates, without disposing the tubers much to destruction, therefore different from the phytophtora. But the effect of the verticillium shows itself when the potato is planted. Every new shoot which it sends forth contains the emissaries of the fungus in luxurious and abundant growth, and the new tissue is mostly so loaded that the entire shoot dies before it is many inches above ground. But if it reaches its natural height, the leaves are all frizzled, and the stalk does not make either flower or seed, though itself is not always permeated by the fungus, which, when it comes from the potato, mostly is, and remains confined to the part below ground. After the young shoots have perished, the potato also perishes; in case the plant survives at all, it mostly forms no new tubers; if it form any, they are

weak and small, and die in the next attempt at reproduction. The disease can be transferred by inoculation upon previously healthy plants. On the tuber the fungus remains near the cork peel without penetrating much into the inner parts, but by the ultimate results, it kills the potato as effectually as the phytophtora.

In cases in which the disease arises from the planting of infected potatoes it is irremediable; but when it invades an otherwise healthy crop in the shape of spores, its spread might be arrested, like that of the oïdium on vines, by proper sulphuring.

The economic effects of the potato disease, particularly that produced by the phytophtora, have been of very great extent and intensity in many parts of Europe and North America. The benefits which the introduction of the potato has no doubt conferred upon past generations have, then, turned to the very reverse, and the failure of the potato worked destruction amongst entire populations. Thus Ireland, in addition to other troubles, underwent the ordeal of a famine which reduced her population from 8,000,000 to about 5,000,000. It is unquestionable that the economic value of the potato has been overrated, at least as regards its nutritive quality. In this respect the potato is never equal to corn of any kind, and populations which rely upon the potato as their principal food must necessarily degenerate, and be inferior in every respect to populations which feed on corn only, or corn and meat. According to the laws of nutrition, as evolved by Voit, an adult worker requires, when working moderately, at least the following quantities of primary nutritive material in 24 hours:—Albumen, 118 grs.; fat, 56; carbohydrate, 500. Now potatoes contain about 2 per cent. of albuminous matter. In order to supply 118 grs. of albumen out of consumed potato, a man would have to eat 5·9, say very nearly 6 kilos, or 12 lbs. of potatoes. To supply the carbohydrate from potato only, he would have to eat 2½ kilos, or 5 lbs. of potatoes in 24 hours, with at least ½ lb. of meat to supply the failing albumen. For potatoes contain only 20 per cent. of carbohydrate. Now even if an Irish labourer in Ireland could eat as much as 12 lbs. of potatoes in 24 hours, he would be mechanically incommoded by the perfectly useless excess of the starchy element contained in 3·4 kilos, or nearly 7 lbs. of potatoes. This would at once cause an abnormal enlargement of his digestive organs, and the healthier he was, the more would he be misshapen by a prominent abdomen. Most persons, however, cannot thus accommodate their natural construction to external necessity, and consequently, if restricted to potatoes, remain underfed. In any case, a population restricted to potatoes as a regular diet cannot be either happy, healthy, strong, or sane. Therefore the Irish people, or that part of it which is restricted largely to potatoes, can never be contented, and in order to enable them to become so, it will be necessary to enable them to feed themselves physiologically. The altered circumstances of trade, the increased facilities of transport, have now made breadstuffs so cheap, and of such excellent quality, that if we can only find a kind of work exchangeable for value, the feeding of a population like that in the needy parts of Ireland ought to present no insuperable difficulty. But the potato must cease to be the mainstay, and in that case not only will political contentment follow, but such famines, as that of 1845-46, caused by vegetable epidemics, with all their train of disease, death, crime, and emigration, will become impossible.

The economic disturbances caused by the potato disease are equally great in parts where the plant is cultivated for the purpose of being manufactured into starch glucose and brandy. The farmer who produces spirit from potato does not impoverish his farm if he retains the mash or wash, and only sells the distilled spirit; whereas, he who sells the entire potato or sells corn impoverishes his soil, and has to supply costly manure from the outside. It is for this very good reason that spirit production is so popular on the great estates of central and eastern Germany. Now you can calculate the economic disturbance which any degree of prevalence of phytophtora must cause in the Schnapps industry, and all connected therewith. Our port wine and sherry are affected not only by the oïdium or phylloxera, but also by the phytophtora. For as Berlin spirit, which is in reality the purest alcohol in the market, forms half the alcohol in port and sherry, anything affecting the staple affects the product.

There is a kind of phytophtora which causes great ravages in young beech plantations (the *Ph. Fagi*). It infects the young shoot after it has risen above the cotyledons, and seems to enter at the stem of the latter; it spreads in a few days through the entire plant, causes it first to be discoloured and then to die. It thrives in shady better than in sunny situations, and kills from 70 to 80 per cent. of all young

plants. The mycelium lives in the cotyledon, and there forms not only carriers of conidia which are sent into the air, but also oogonia and antheridia in the interior itself. The oogonia are very numerous, and each contains an oospore with a hard skin. It is by these oospores that the beech-phytophtora is most commonly propagated and spread, for, according to R. Hartig, a single cotyledon may contain 700,000 oospores. Earth infected with them can transfer the disease to previously clear plantations; in Hartig's experiment a handful of infected earth placed in a beech plantation destroyed in a few days all, that is to say, 8,000 plants.

In conclusion, I will give two short illustrations from my garden experience, which show the importance of a knowledge of the habits of parasitic fungi. I once watered a frame of flourishing young wallflowers with water taken from a tap in an outhouse, the ordinary tap happening to be dry. Within a few days the whole of my wallflowers were penetrated by a peronospore, and in a short time my frame did not contain a healthy, hardly a living, plant. No doubt the tank water was permeated by spores, which, finding a *nidus* on the wallflowers, soon accomplished their mission. In a conservatory attached to my house we like to grow mignonette in wooden troughs, to scent the place and the house in the summer time. For two summers the mignonette plants were destroyed by a peronospore which acted like a *rhizoctonia*, or root-killer. The fungus enters the young plant at the point where root and stem join, and here produces frequently an anthracoid thickening on one side, and an atrophy on the opposite, so that most plants are fixed at an angle to the soil, and do not stand perpendicularly. The leaves appear sickly, yellowish, and small; the stems remain thin, and produce small weak flowers, and never any seeds. The plants die young, half-grown, and in flower, and on examination all show the fungus in greatest development between the epidermis and pulp of the root, so that the epidermis can sometimes be stripped off the root like a glove from the fingers. I could not get rid of this parasite except by destroying the earth and all wooden boxes by fire, and growing no mignonette in the conservatory for two years.

The peronosporeæ, which are closely related to the phytophtoræ, have many genera and species which affect a great variety of wild and cultivated plants; thus without multiplying names of parasites, I only mention some hosts:—parsley, carrots, American vines, lettuce, artichokes, chicory, the varieties of cacti cultivated in conservatories, linseed, vetches, lentils, peas, spinach, shamrock, poppy, onion, leek, sorrel, beet-plant—and thereby dangerous to the sugar industry—and a great number of wild plants or weeds. With the systematic botanists we pass from the peronosporeæ through the genera of the basidiophora, which are rare, and practically insignificant, and the cystopodia, which live within a variety of weeds, and in horseradish, into the family of the ustilagineæ, with which we will begin our next lecture.

Miscellaneous.

CENTRAL AFRICAN AGRICULTURE.

The Masai are fond of some barks, which they either chew or boil with their meat, and, doubtless, these will be found to possess valuable therapeutic qualities

The most common grain of the Walungu, on Lake Tanganyika, is *uleysi*, cultivated in circular forest clearings, watched from huts on high poles.

The plants cultivated for food on the shores of Lake Tanganyika are rice, manioc (*Jatropha*), Kaffir corn (*Holcus sorghum*), two kinds of ground nuts (*Arachis hypogæa* and *Voandzeia subterranea*) whose oil is excellent, maize, *uleysi* (*Eleusine corocana*), pumpkins, sweet potatoes, and sugar-cane, while the castor-oil plant, tamarind, cotton, tomato, and cucumber, grow wild around nearly every village. The oil palm (*Elæis guineensis*) is met with at Ujiji, Urundi, and the south end of the lake; *Raphia* in several localities, *Borassus* largely on the margin of the Malagarasi river, *Pandanus* in Uguha. Among the useful timber trees may be specially noticed the gigantic *mdule*, out of which canoes are hewn, the mininga or African teak, lignum vitæ, and "ebony;" a variety of woods useful for smaller purposes are also to be found, and are worked by the natives.

On Lake Nyassa, use is made of cassava meal (*ufa*), of a building timber called *masuku*, and of a plant called *buaze*, which grows plentifully in some places, and is employed for making cloth and fishing nets.

The most esteemed fuel on the Upper Nile is *sun* (*Acacia arabica*).

In the district of Usmao there is a large amount of cultivation, *mtama*, *mwere*, maize (*mhindi*), ground nuts (*Arachis*), and sesamum, being the chief products. A species of *Euphorbia* (probably *E. antiquorum*) is grown for hedges. A small quantity of red rice is cultivated; it is an inferior kind, smaller in the grain than the ordinary rice, with a husk of reddish-brown colour.

Among the Wahehe very little ground is cultivated; they produce two kinds of millet, maize, and a few sweet potatoes.

On the Uchungwe mountains, the inhabitants cultivate a few sweet potatoes, maize, and a grain called *unliza*.

The country around the river Djour or Bahr el Ghazal produces many "butter trees," called by the natives *lulu*; the butter is used for cooking, and would probably make a good lubricant.

In Uganda the only native plants or trees at present known to be of any commercial value are a kind of nutmeg, which grows abundantly near the lake (Tanganyika), coffee, of which the berries are sometimes chewed, but never taken in infusion, several species of *Euphorbia*, as well as some other plants producing rubber of good quality, and the *mpafu*, a large tree which yields a sweet-scented gum-resin, much valued by the natives. Wheat, rice, papaw, pomegranate, guava, and banana flourish, the last-named being largely consumed as food.

In Ukara, millet, semsem, sweet potatoes, bananas, beans, *pojo*, *wimbi*, and *kinanga* are grown, but neither maize, cassava, nor cotton. The corn, if either pounded in a wooden mortar or ground on a flat stone, beneath which is spread a cowhide to catch the flour. Porridge is the staple food.

In Kavirondo, on the eastern shore of the Victoria Nyanza, the people grow millet, beans, bananas, and enormous quantities of sweet potatoes. There are two harvests yearly. The staple food is a thick porridge, made with milk on festival occasions, and eaten with the hands. Split bananas or sweet potatoes, dried in the sun, are known as *makopa*.

The people on Katogo Island, in Lake Tanganyika, cultivate fan-palms and eat the fruit, but do not make toddy from the juice.

The Cazembe's country abounds in manioc, white gourds, ground nuts (*Arachis hypogœa*), *jugo* (a small haricot like the ricinus, white sugar-cane, sweet potato, and *dendé* or *dendem* (the palm-oil tree). There is also a quantity of the *nhamudoro* bean (*Cajanus indicus*). Dry manioc flour is called *bobo*. A wine called *sura* is extracted from a wild palm, variously called *uchinda*, or *mediuca*, or *mediqua*, and is preferred by some travellers to that yielded by ecoe tnthcon palm. All manioc meal is made in the same way: the roots are soaked for three days, peeled, and sun or fire-dried whole; next, pounded and ground on a stone when wanted for use; and, finally, made into dough or unleavened bread. The people also occasionally eat the sweet manioc (*Jatropha utilissima*) roasted; containing no poisonous principle, it does not require soaking. There is an abundance of "larger" and "lesser millet," here called *masamballa* (*Holcus Sorghum*) and *luco* (*Panicum spicatum*), also a grain called *mosango*, probably *Eleusine coracana*. The l af of the sweet potato makes a tolerable salad.

In Minyoro, the sweet potato and banana are extensively cultivated, and form the staple food, but *durra* (*Sorghum vulgare*) and *tullaboon* (*Eleusine coracana*) are also grown, as well as a small kind of maize.

Correspondence.

POPULAR BEVERAGES.

A Member writes:—"Amongst other popular beverages not mentioned by Mr. P. L. Simmonds, is one which is little known in this country, but if once tried it will be found to combine almost all the desirable qualities in itself, as a light drink which can be freely used by all. To make this, boil from 1 lb. to 2 lbs. of apples in water until they are dissolved, or rather until they form a soup with the water; add boiling water to make up a gallon, and from $\frac{1}{2}$ lb. to $\frac{3}{4}$ lb. of sugar; when nearly cool add a little yeast, and when the fermentation is well advanced strain and bottle, tying the corks tightly down. It will be ready for use in two days, and remains in its best condition about a week, so that a weekly 'brew' will keep up a continuous supply. The quantity of apples and sugar may be varied to suit individual tastes. The process of manufacture resembles that of the well-known ginger beer, but the result is essentially different, the flavour, when properly made, being more like champagne, without the intoxicating effects of the latter, and it only needs to be generally known to be fully appreciated."

General Notes.

Inventions Exhibition, 1885.—The accounts of this Exhibition have now been published. They show the receipts and payments of this Exhibition from August 12th, 1884, to July 30th, 1887. The receipts were £214,403, among which the following were the principal items:—Admissions, £149,825; royalties from the refreshment contractors and others, £18,627; publications, £8,580; realisation of buildings and plant (Colonial and Indian Exhibition, 1886), £16,325; surplus fund from the Health Exhibition of 1884, £15,516; balance made good by Colonial Exhibition, 1886, £2,573. On the other side the following are the most important items of expenditure:—Buildings, £30,778; plant taken over from Health Exhibition, £4,051; rent, £4,129, including £3,000 to the Royal Albert Hall Corporation; rates and taxes, £3,430; working of electric exhibits and electric lighting, £37,521; garden illuminations, £9,213; illuminated fountains, £3,107; motive power for the machinery exhibits, £14,848; salaries of the officials, £6,219; wages of the servants, £18,845; publications, £10,829; postage, £3,661; advertisements, £14,970; reception and delivery of exhibits, £5,230; juries, £2,109; medals and diplomas, £3,078; music, £17,039, including £10,192 for the military bands, and £6,113 for the Strauss orchestra; music loan collection, prizes, &c., £4,913.

Journal of the Society of Arts.

No. 1,816. Vol. XXXV.

FRIDAY, SEPTEMBER 9, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

EXAMINATIONS, 1888.

The Programme for 1888 is now ready.

The subjects in which Examinations are held are as follows:—(1) Arithmetic; (2) English, including composition and correspondence, and *précis* writing; (3) Book-keeping; (4) Commercial Geography and History; (5) Shorthand; (6) French; (7) German; (8) Italian; (9) Spanish; (10) Political Economy; (11) Domestic Economy; (12) Theory of Music; (13) Practical Music.

The Examinations are held at all places in the United Kingdom where suitable Committees can be formed. A fee of 2s. 6d. is required from each candidate in each subject, except Practical Music, for which special fees are charged. 1st, 2nd, and 3rd class certificates are given in each subject.

The Examinations will be held on the 9th, 10th, 11th, and 12th of April.

The Practical Examination in Vocal and Instrumental Music will be held in the Society's house during the week commencing on May 21st.

The Programme can be had gratis on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE DISEASES OF PLANTS, WITH SPECIAL REGARD TO AGRICULTURE AND FORESTRY.

By J. L. W. Thudichum, M.D., F.R.C.P. Lond.

Lecture II.—Delivered January 31, 1887.

In the first lecture, it was conclusively shown that some of the most destructive of vegetable disease-causes belong to the class of *Parasitic fungi;* that fungi, by the force of their organisation, which does not enable them to produce chlorophyll (hence called *achlorophyta*), by means of which the power of light is used for the combining of inorganic or mineral substances so as to produce the more complicated substances which serve for the building up of the vegetable and animal organism, *are obliged* to draw their nutriment from sources which already contain these organoplastic matters, that this food may be present in living as well as dead matter, and accordingly that fungi choose either the one or the other for ministering to their wants. Those which live upon dead animal or vegetable matters and the products of their decay are termed *saprophytes.* They are not parasites in the true sense of the word, and when they are found upon living tissues it may always be seen that they exist exterior to their tissues on their surfaces in mortified parts or decomposing secretions. The true vegetable parasites live upon or in and at the expense of the living substance of other plants, penetrate their substance either partially or entirely, and not rarely to such a degree that these hosts—as the plants maintaining the parasites are called—perish. When the parasite lives upon the outside of a plant it is called an *epiphyte,* when within the tissue of the host, an *endophyte.* Endophytes are not always or absolutely within their hosts, but at the period mainly of their fructification, they project organs from the interior of the host on to its surface, whence the seeds, which in the case of fungi are termed *spores,* are subaërially distributed, and thus by falling upon new hosts propagate the species. The simplest parasites—namely, those which consist of one cell only—may live within a cell of the host, or upon it, or between a number of cells, that is to say, in the parenchyma.

Now, after having considered the most important endophytes, such as have led to national calamities, we come to consider some other endophytic fungi, which are numerous as regards genera, and wide spread as regards geographical distribution, but do not multiply under favourable circumstances in so destructive a manner as the phytophtora, or more generally, the peronosporeæ. These are the *smuts, brands, rusts,* and *scabs.*

History.—Smut was known to the ancients, and described as "uredo" (from "urere," to burn). This name arose from the black colour, which was believed to be the result of heat or

disease, similar to gangrene in parts of the human body. Pliny and Theophrastus were of opinion that any uredo was the result of bad weather, an opinion which has persisted down to our own times, although Persoon already in 1801, in his "Synopsis Fungorum," described the smuts as fungi. Turpin and Schleiden were yet of opinion that the smuts were only pathologically altered cell-tissue of the affected plants and not parasites. Unger and Meyen, although admitting uredos to be fungi, believed that they arose from spontaneous generation, notwithstanding that Prévost had already, in 1807, discovered their spores, and shown that they germinate. This germination was more fully demonstrated by the brothers Tulasne, in 1854. The first experiments for the purpose of infecting healthy plants with microscopically-identified spores, and observing their development, were made by Kühn, in 1858 (Krankh. d. Kulturgewächse, Berlin, 1859), with *Tilletia caries*; by Hoffmann, in 1866, with *Ustilago carbo*; and by Wolff, in 1873, with a variety of similar fungi. There can now be no doubt that these smuts are independent fungi, which settle upon a healthy plant, and live and reproduce their kind at the expense of their host. Indeed, this was synthetically proved already in 1781, as we shall see more distinctly hereafter.

The *ustilagineæ* are a numerous family; there are at present more than 140 species known, which live upon more than 300 species of hosts. From this you will see that it would be quite impossible for me to give you a systematic account of them, even if such an attempt were of the greatest interest and value to you. I shall therefore attempt only a general definition, and the description of some prominent examples.

The ustilagines attract the attention of the people because they appear on all kinds of corn-plants, and destroy the seed, or corn. What should be a healthy grain is by these parasites transformed into a capsule filled with black or brown dust; or what happens with equal frequency, the capsule also is destroyed, the dust is dispersed, and only a black stump remains in the place which should have been occupied by a seed. The black or brown mass consists of the seeds of the fungi, called spores. These are produced by mycelia, which thrive within the tissue of the host, and grow directly out of the hyphæ of the mycelium, without the intermediate aid of seed-capsules.

Of the many different parasitisms due to ustilagines, generally only one occurs on one particular species of host; if a smut occurs on two different species of hosts, the latter are generally closely related to each other in a botanical sense. This fact explains the apparent excess in the number of hosts over that allowed by the law of monœcia, the proportion of parasites to hosts being 140 to 300, given before. The different species of parasites prefer *different, and always specific parts of the hosts* which they invade. Some live in blossoms, mostly the seed-capsule; some in stamina, some in seeds; some thrive in leaves, some in stalks, others in roots. This constancy of the connection between parasite and host is very similar to that in the animal series; the *Tænia echinococcus* comes to maturity only in the dog's (or wolf's) intestine; the young brood of the *Tænia grandis* thrives only in the cellular tissue of the calf, the full-grown tapeworm only in man; the eggs of the *Tænia solium* can be reared in the young pig only, the full grown Tænia in the human subject only, and so on. Many animals which at some period of their life feed upon plants, are restricted to one particular plant for their food, as all those know well who have to do with the rearing of caterpillars. So the smut seeds, if they do not find the particular appropriate host, perish, mostly, after an abortive attempt to get a living on uncongenial soil, in which they spend their own substance.

Those spores which arrive on the surface of an appropriate host, enter its tissue in a manner resembling that which I have described as exhibited by the spores of the phytophtora. They grow into the tissue, probably with the aid of some chemical corrosive or fermentative excretion. The asci then form hyphæ in numbers, and send sprouts in all directions. But not in all parts of the host can the ustilago come to fructification; and while, *e.g.*, on wheat it may enter the plant when it is only a few inches high, and vegetate in and with it until it has attained its full height, it developes spores only in the ear, during the time from the blossoming to the ripening of the seed.

From this you will see that the ustilagines propagate in a manner different from the peronosporeæ; they must be sown probably already with the seed, and grow up with the plant, and a plant which is invaded cannot infect its neighbour, as one sick potato plant can infect its neighbour; and for this reason the ustilagines can never become epidemic and

destructive to the same degree as we have seen the phytophtora and peronospora to be. The spores of the ustilagines have a considerable duration of life; those of *Ustilago carbo* are known to germinate after $2\frac{1}{2}$ years, those of *Ustilago destruens* after $3\frac{1}{2}$ years, those of *U. Maydis* and *Tilletia caries* after more than two years' keeping.

The spores of the ustilagines, when they germinate on soil on which they cannot feed or grow, perform a feat of development by means of which they obtain a chance of reproduction at a later, and it may be long deferred period. The ascus failing to enter the plant, on which the spore had descended, and which proved not to be its natural host, grows into a hypha with several branches, called a *promycelium;* these branches form again at their ends seed-like organs, somewhat smaller than spores, and called *sporidia;* and these latter take up all the nutriment contained in the original spore; the whole process is accomplished with the aid of a little water only. These sporidia can reproduce the plant in a subsequent season. The manner in which sporidia are formed, and their shape, has been made use of to distinguish and classify the ustilagines.

That the ustilago on grain could be propagated by sowing the spores together with the grain seed was proved by Gleichen, in 1781, in the interesting German work, "Selected Microscopic Discoveries," Nürnberg, 1781, p. 46. This author sowed on three pieces of land wheat grains, not counted, in three different conditions:—

1. Wet and mixed with spores, he harvested 178 healthy, and 166 smutty infected ears.

2. Wet, but pure, he harvested 340 healthy, and 3 smutty infected ears.

3. Dry, and sown pure, he harvested 300 healthy, and 3 smutty infected ears.

In another experiment he sowed summer wheat on four pieces of land, in the following condition:—

1. Wet, and mixed with spores from wheat, gave 339 healthy, and 188 infected ears.

2. Wet, and mixed with spores from barley, gave 168 healthy, and 234 infected ears.

3. Wet, and sown pure, gave 198 healthy, and no infected ears.

4. Dry, and sown pure, gave 102 healthy, and no infected ears.

Nearly 100 years later, in 1876, Kühn, of Halle, made a similar experiment with millet, to which he had added the spores of *Ustilago destruens.* Out of every 100 plants which rose 98 were infected.

From these facts it is evident that the principal mode in which corn crops, sown on land which had not borne similar crops in the previous year, become infected, is by fungus spores which adhere to the seed-grains, and enter the ground with them at sowing time. Consequently the principal mode of preventing the formation of these destructive parasites consists in removing or destroying the spores attached to the grain. Already Prévost has shown that this can be effected by means of a very old popular remedy, caustic lime, or better by the remedy which he discovered, namely, sulphate of copper (blue vitriol). When he mixed spores with grain, and sowed it without previous disinfection, he had *one-third* of all ears ustilaginous. When the corn simply was sown, without added spores, or disinfectant, he harvested one ustilaginous ear upon 150 healthy ears. But when he infected corn with spores, and disinfected it again with cupric vitriol, he harvested only one ustilaginous ear upon 4,000 healthy ears. When Plathner disinfected ustilaginous wheat, which would have yielded two-thirds of its crop in a ustilaginous state, he found the following proportions in the effects of the several disinfectants:—

1,000 grains, winnowed in air, gave 422 ustilaginous ears.

1,000 grains, washed with pure water, gave 116 ustilaginous ears.

1,000 grains, disinfected with lime, gave 68 ustilaginous ears.

1,000 grains, disinfected with copper vitriol, gave 30 ustilaginous ears.

The corn may be steeped in a solution of the vitriol for from 12 to 16 hours, without losing any of its vitality. Some take the corn out of the solution and then wash it. Some pour the solution of vitriol over the corn, shovel it well about, and let the vitriol dry on the corn previous to sowing. I took great personal interest in this operation, years ago, while residing on the farm of a near relative. The corn was washed, then formed in a long ridge with a furrow at the top, and in this a concentrated solution of copper vitriol was gradually poured. The corn was shovelled too and fro, again formed into a ridge and furrow, and again treated with copper solution. This was repeated until the copper solution was no longer retained by the corn, and it could be assumed that each grain had been touched by it all over. The corn was then spread, slightly dried in the air, and immediately sown. From seed-corn so treated

there were never any ustilaginous ears propuced.

With regard to straw from ustilaginous crops it is clear that a great number of spores must be attached to it. When this is used for litter and becomes manure, the spores grow and form the promycelia and sporidia, above described. When these are brought upon land to be sown with corn, they may infect any grain with which they come into immediate contact. But of this the chances are so rare or remote that, in this manner—namely, by ustilaginous straw in manure—infection is practically not often brought about; there are, however, cases recorded where such infection has occurred. When a crop has been infected with ustilago, it is certain that the ground below and the land in the windward direction from it must contain abundance of spores. Such land would be liable, the season favouring, to be again productive of ustilago in the next year, if it were sown with a corn crop of the same or a similar kind, liable to the parasitism. Against this eventuality the practice of the rotation of crops, which is also found useful for many other reasons, affords a good security. On the whole, I have no doubt that the agriculturist, who is fully acquainted with the natural history of the ustilagines, and with the known means for their destruction and exclusion from his fields, will be able to so limit their life and development as to keep his cash account beyond the range of their sensible influence.

We will now rapidly review a selection of ustilaginous fungi, such as affect the most important cultivated plants. I must premise, as regards nomenclature, that formerly ustilagineæ were not separated from uredineæ, and thus you find the anomaly that several species of the former do yet, in literature, bear the name of "uredo," while they must be and are ranged under the genus "ustilago," and therefore can no longer be placed in the category of uredineæ. Thus the *Ustilago carbo* of Tulasne was by Persoon termed *Uredo segetum*, and by De Candolle, *Uredo carbo*. It is the commonest smut on oats, barley, and wheat (but does not occur on rye), and on a variety of meadow grasses, particularly the French rye grass (*Arrhenatherum elatius*). While travelling in the Midland Counties last summer, I saw many large fields infested with it, and felt quite sure that the amount of healthy corn on the areas which I saw could not pay the agricultural expenses, much less pay any rent to the landlord or interest to the proprietor. I looked upon the event as evidence of bad husbandry, and it was one of the principal causes which brought me here to deliver these lectures. The spores of the *Ustilago carbo* are amongst the smallest, being from 0·007 to 0·008 mm. in diameter.

The *Ustilago destruens* does much damage on crops of millet in parts of Italy. The *Tilletia sorghi* does much damage upon the sweet grass called sorghum (a larger variety of millet, which, like young sugar cane, is eaten raw as a green vegetable, while its mature seed is eaten like millet) in Egypt, Abyssinia, Greece, Italy, and the south of France. (Sorghi is an Indian name for the plant.) The genus to which sorghum belongs was called by Linné *holcus*, and it counts at least six species.

The *Ustilago maydis* produces the most grotesque malformation I have ever seen on vegetables. Where there ought to be an ordinary seed stalk, you see an enormous brownish-black formation of the size of the largest pineapple; it is covered with black dust, the spores, which exude out of capsules looking like distorted almonds, each such capsule represents what should have been a maize seed. A Mexican lady informed me that these formations are considered in Mexico as delicacies, and eaten stewed and fried, in the same manner as mushrooms and truffles are eaten with us. A different kind of ustilago has been observed by Passerini upon maize plants in the environs of Parma, where it spoiled fully one-half of the crop.

The *Ustilago secalis*, of rye, is rare, and has as yet been observed only in Bohemia and Italy.

The *Ustilago grandis* flourishes in the internodes of the ordinary reed (*Phragmites communis*), and causes them to be of the size of bulrush clubs. Peculiar fungi of this genus occur on Cyperaceæ, Juncaceœ, and Liliaceæ. Amongst the latter the common squill (*Scilla maritima*), is much disfigured in its beautiful blossom by this parasite.

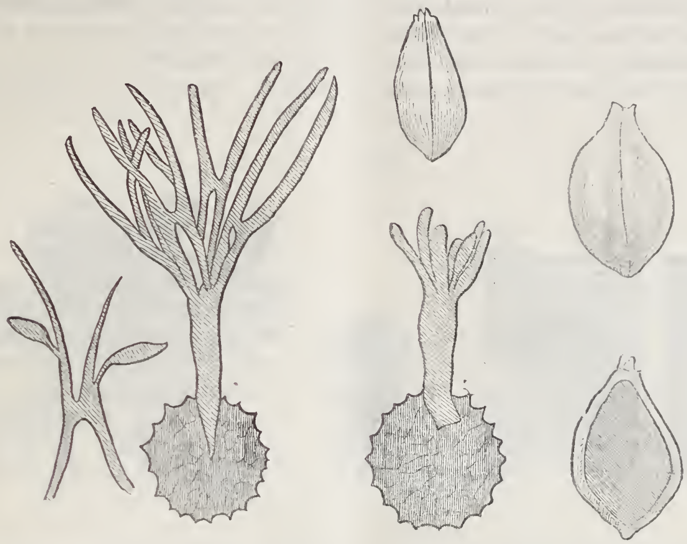
The *Ustilago phœnicis* invades the date palm, and its spores are found as a blackish violet powder in the place of the sweet flesh between the skin and kernel.

Of ustilagines, twenty-one genera are well known, of which those I do not mention live upon uncultivated plants. The genus *Tilletia* was established by Tulasne, and further investigated by Kühn, Cohn, and von Waldheim. It is of particular interest, inasmuch as at

least one species produces chemical compounds which are external to the mycelium and spores, that is to say, secreted or excreted, a feature which may aid in the investigation of the hypothetical fermentation or caustic action of other fungi.

The *Tilletia caries* is confined to wheat and spelt. It fills the entire grain capsule, which is slightly enlarged, as a coal-black mass of spores. The rough spores, covered with an episporium of polygonal cells, germinate easily, and produce a promycelium consisting at first

FIG. 8.



of single hyphæ; of these, two and two then couple and form a double spore of the figure)(. Out of this now may grow sporidia, or the ascus of immediate growth. This coupling of the sporidia, which seems to be the condition of their subsequent development, is one of the most striking features of that remarkable parasite.

Rye has also its peculiar Tilletia. Kühn found it in 1876 at Ratibor, in Silesia, and Cohn showed that it had been endemic there for at least 30 years. In Moravia also it has been found in abundance.

We must pass over the genera *Geminella*, *Thecaphora*, and *Sorosporium*, and cast a glance at that of *Urocystis*. The latter counts four species, of which one, the *Urocystis occulta*, invades the stalk of rye, while another attacks the onion.

The *Urocystis cepulæ* destroys annually fields of young onions in Massachusetts and Connecticut, U.S.A., and has also been discovered in Saxony, near Leipzig. The plants mostly disappear before they have formed onions. I have never been able to understand why beds sown thickly with onion-seed mostly give such a thin crop of mature product. I should now advise cultivators of this important plant to study its parasites, and to eliminate their effect, should they, as I have no doubt they would, be met with, particularly on the young tender plants. At least four genera related to the Tilletiæ are known to occur on wild plants. They are botanically of extreme interest, but we must be satisfied with having mentioned them.

I may again direct your attention for a moment to the necessity of our using technical terms for defining distinct species of plants, such as we are now considering. The popular terms in use do not suffice, as their number is small, and it would require a very rare kind of genius to coin successful new popular terms. After inspecting, for this purpose, Mr. Cooke's admirable systematic work on fungi, I find again what I have already stated in the first lecture, namely, that fungi belonging to very different genera, are promiscuously termed by the people *brand*, *smut*, *scab*, and *rust*. Thus I find Puccinias = brands; Ustilagos = smuts; Tubarcinea = scab (*e.g.*, on potatoes); Urocystis is again = smut; Uromyces = rust; Uredos are termed uredos, and there is no popular word for this now very much restricted symbol; the Æcidia are termed cluster-cups, which I think a very happy symbol. The

German author Frank terms the Uredineæ, as now botanically restricted "rusts," and I think we shall do well to adopt his nomenclature.

The *rusts* or *Uredineæ*, are endophytic parasites, which live in parts of plants above ground, mostly in stalks and leaves, and cause them to be diseased. They form a common mycelium, with dividing hyphæ, which permeate the tissue of the host. The hyphæ multiply in particular localities, and form organs of sporification; that is to say, a great number of hyphæ shoot up like the hair of a painting brush, or the birch-twigs of a broom, and on the end of each hypha a spore is first formed, then detached, and so on. That end of each hypha which forms the spore is termed a *basidia*. Most rust fungi have several kinds of spores, of which one kind (which, *e.g.*, in the *Puccinia graminis*, Pers., is red) are termed *uredospores*, while another kind (which in the fungus just mentioned is black) are termed *teleutospores*.

Now I must give an explanation of the two last technical terms. *Uredospores*, or *stylospores*, are those seeds which are capable of immediate growth; for this reason they have also been termed *summer spores;* but the *teleutospores* are not capable of immediate growth, because they are disposed so as to last through the winter, and therefore can appropriately be termed *winter spores*; the summer spores differ from the winter spores in shape and appearance; and, further, the summer spores are formed on the brush-like fruit bases more on the outside, earlier, whereas the winter spores are formed more commonly in the centre and heart of the efflorescence. But now observe: the teleutospores proceed to action in their own way. They will survive winter, frost, and all inclemency. They sprout in spring, and produce the *promycelia*, and the *sporidia*, which you already know. These sporidia now adopt a course of life which we have not yet witnessed in any previously discussed genera of vegetable parasites. They settle upon a species and genus of plant different from that on which the uredospores and teleutospores were formed, and there grow into a structure which is termed the *æcidium*. The sporidium gets first on, then into the leaf, and develops into a mycelium, which produces in its turn *a third variety of spores*, which differ in shape from the two varieties previously described. They are orange yellow, not red or black; they are accompanied by bodies termed *spermogonia*, which produce spermatia, but the exact function of these latter bodies is not yet quite certainly determined. For the direct succession, the third variety, or *æcidium spores*, are alone valid. These, on arriving on the primary host, reproduce the original rust, and then the cycle is concluded. This change of host has been termed *heterœcia*. Some rusts pass through the same changes on the same host, and these have

FIG. 9.

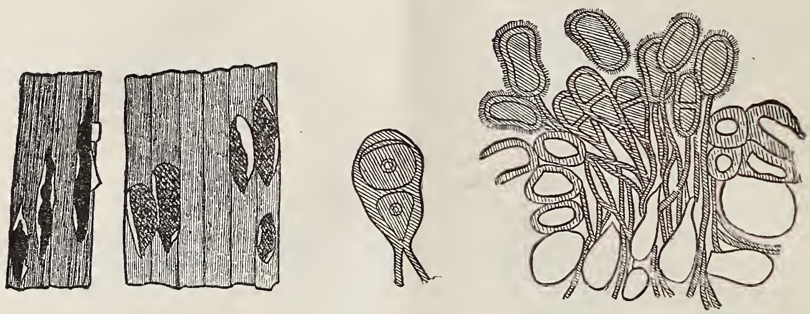
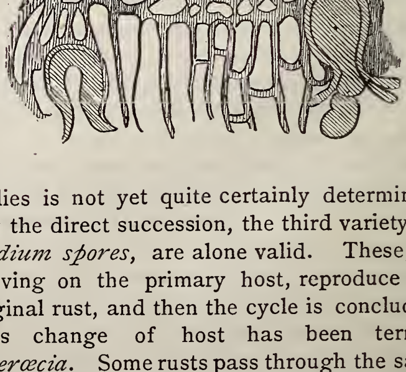


FIG. 10.



been termed *autœcic* parasites. These parasitic plants, therefore, undergo changes of host and shape very similar to those of many animal parasites; if the æcidia spores, are, as is not improbably alleged, fertilised by the spermatia, then we can compare them to the ova of the *Taenia echinococcus* produced in the dog's intestine, whereas the early echinococcus bladders and heads, formed in the livers of oxen or sheep, may be compared to the summer spores, and the later endogenously formed heads to the winter or teleutospores. The analogy here sketched gains by continued comparison of the two cases, but we must now leave its further consideration.

The pathological effects which rusts produce upon their hosts may be described in general terms either as atrophy and consumption (the plants become yellow, thin, and die); or as tumefaction, and formation of galls (the plants become misshapen, and after that cease to develop any further). When the fungus dies, the invaded and malformed part also generally dies, and the plant is further injured by contact of the healthy tissue with decaying tissue and all its eventual guests and products. The formation of rusts is most successfully prevented by the destruction of all spores, more particularly the teleutospores; and further by the removal of those hosts which, while uncultivated and of relatively little use, give development to the æcidia.

The rust of corn plants was known to the Greeks under the name of ἐρυσίβη, and to the Romans under that of *rubigo* or *robigo*. The latter had a feast, *robigalia*, during which the gods, or even the particular god of rust, *Robigus*, were propitiated to keep the rust down.

I will now rapidly consider the most important rusts, in the first place those of the gramineæ. There are first the *puccinias* of grass or corn; they are *heterœcic*, and their *æcidium* lives on the leaves of the barley-plant (*Berberis vulgaris*). The details of these parasitisms would require a lecture for themselves; I must, therefore, be satisfied to state to you that there are at least five genera, living on as many natural families, with a considerable number of species in each, known to systematic science. The *autœcic puccinias* count at present at least twenty-two genera, on as many natural families, with several species each. Rusts thus are dangerous parasites to all kinds of cereals, to onions, liliaceous plants, to asparagus, to composites, *e.g.*, the ornamental chrysanthemums; violets and pansies; currant and gooseberry bushes; plum and almond trees; not to mention a great number of uncultivated plants. Amongst the latter is a weed, a common thistle, *Cirsium arvense*, the host of a puccinia which belongs to the curiosities amongst these organisms. The *Puccinia suaveolens*, the sweet smelling puccinia, pervades in the state of hyphæ the entire young thistle plant, and seems to irritate it to quicker and higher growth than is attained by healthy plants or uninfected sprouts. When the leaves are fully formed, their undersides become covered with countless spermogonia, which spread a peculiar agreeable odour round the entire thistle plant. Upon that follow the rustbrown dustlike masses of uredospores, originally called *Uredo suaveolens* by Persoon.

The puccinias are indigenous to all climates and parts of the world, and are as cosmopolitan as man himself. Thus a puccinia at home in Chile on malvaceous plants, has lately been imported into Europe, and is now pretty well distributed and at home over the whole of it. It revenges the importation of small-pox by the white race into the small-pox free territory of the American Indians; or the importation of measles on to the islands of the Pacific, for it is also present in Australia. In 1869 it was found in Spain; in 1873 in France and England; in the autumn of that year it had reached Germany, and the Baltic island of Fünen; and in the South had reached Rome and Naples; in 1875 it spread northwards and eastwards on the Continent, and reached Hungary in 1876; in 1877 it appeared in Switzerland, and in Greece, at Athens. It will soon be ubiquitous, and add greatly to the trouble which has for some time been connected with the rearing of malvaceous plants.

A second group of the rusts are the *Uromyces*, distinguished from the first mainly by the fact that their teleutospores consist of one cell or cavity only, whereas the teleutospores of the puccinias have mainly spores divided in two compartments, though amongst them spores with only one compartment also occur. We know six genera of uromyces on as many natural families, with many more species. One species, *Uromyces betæ* (Tul.), settles on the leaves of the sugar-beet, and is capable of doing great damage to these crops, though its ravages have not yet raised the price of sugar, which our brethren on the Continent are so kind as to send us at such low, self-sacrificing rates. Another genus settles upon papilion-

aceous plants, such as vetches and beans, peas, lupins, clover, and counts at least seven species.

A third group comprises the genus *Triphragmium*, in which the teleutospores show mostly three chambers. A fourth group is termed *Phragmidium*, and comprises four genera with many species. One of these infests the blackberries, another the roses, wild and cultivated. The teleutospores are club-shaped, like a minute bulrush, and divided in from seven to nine disk-shaped cells or compartments.

The fifth group of rust is *Xenodochus*, the sixth *Pileolaria*, to which latter belongs the *Pileolaria terebinthi* (Cart.), which lives on the pistachio tree. The seventh group is termed *Gymnosporangium*, and comprises the principal rusts so common on, and destructive of, fruit trees, particularly pear trees. On these they sit, on the underside of the leaves, in groups easily discernible by the unaided eye. They occur also on the leaves of apple, mespilus, sorbus, and whitethorn trees and bushes.

The eighth group, *Chrysomyxa*, affects mainly the pine tree, *Abies*, and is distinguished by brushes of teleutospores, which are divided into a number of cylindrical compartments, and filled with an orange-coloured oil. This colour of the rust, and the additional pallor of the green colour of the needles, has produced for the diseased condition of the pine trees—and, let me add, not rarely pine forests—the name of jaundice of the pine tree. This is a severe affection of these particular conifers, and when it has once taken hold of a plantation, the forester must not hesitate to cut out all affected branches or trees. The spread of the disease in the pine forest of the Hartz became, in 1831, and repeatedly since, quite alarming; entire forest slopes looked yellow, and their prosperity was seriously jeopardised. It lives on the pine in all altitudes and in all situations; in 1850 it was discovered on the Erzgebirge, in Hesse, and in Bavaria, near Munich. But it is not found in the Bavarian or Austrian Alps, where it is replaced on the pine by another rust, the *Æcidium abietinum*.

The ninth group of rusts lives on the pitch pines, and is termed *Coleosporium*, and has been found in Finland, on *Pinus strobus*, in Bavaria, and in the Himalaya. The group has four genera with many species.

The tenth group is termed *Melampsora*, distinguished by the arrangement of the teleutospores, which stand closely packed, under the epidermis of the leaf of the host, and perpendicularly to it. It has its representatives on the linen plant, the willows, birches, and beeches, and counts eight genera with many species.

The eleventh group, *Calyptospora* (Kühn), is represented by only one parasite, the one living on the wortle-berry shrub.

The twelfth and last group is that of *Cronartium* (Frank), which has three genera, and many species.

There are some varieties of æcidia, which have not yet been arranged, because their full life history is not known. One produces the so-called *witch-broom or cancer of the bark of the silver-pine*, the trees which form so many beautiful forests in the Vosges and in the Black Forest, and which can be seen in great perfection in the forests round Baden-Baden and in the Murg valley. Other æcidia have been called *Caeoma*, by Tulasne. Of this one species infects the young pitch pines below ten years of age, and is termed *Caeoma pinitorquum;* it causes the young trees to become twisted. Hartig enumerates more than thirty places where it existed extensively since 1860.

To the rusts belongs also a fungus which has been observed in 1869 on the leaves of the coffee tree in Ceylon, in South India, and Sumatra *(Hemileia vastatrix)*.

The last class of endophytic parasitisms which we have to consider is that caused by a group of fungi which are termed in botany *Hymenomycetes*, because the basis from which spores are developed forms not a brush of aggregated *basidia*, or mother-cells, but a continuous membrane, termed a *hymenium*. This group of plants is so numerous, that, *e.g.*, Mr. Cooke's pictorial atlas, accompanying his handbook, forms two large octavo volumes. The hymenomycetes are marvels of variety in shape, size, colour, and location; they are the regular scavengers of the vegetable world, giving to matter already compounded by the united action of the chlorophyll-green bioplasm and the rays of the sun, a new temporary form, before it again resolves itself into the elementary dryads or triads out of which it was compounded. For our present purpose, however, the consideration of diseases of plants, that is to say the injuries which they suffer during life, we have to consider only few of these fungi, because happily the overwhelming majority are not parasites, but saprophytes in the true sense of the word.

We pass over the order *Exobasidium*, as it affects only a few wild or ornamental shrubs, and consider the second order comprising *the larger fungi which are parasitic on trees*. They settle on healthy trees, permeate their tissue, the stems, branches, or roots, and cause the death of the invaded parts. In the dead parts the fungi now come to their final stage, the development of the fruiting layer, or hymenium, on a more or less developed mycelium. It is this peculiarity, and the fact that they can be cultivated to a certain extent on vegetable matter, which has caused these dead parasites to be so long considered as mere saprophytes. According to Hartig they can and do act frequently as pure parasites; but no doubt previously existing damages of their hosts aid their entry to their healthy tissue as well as the reappearance of their organs of fructification on the surface. When the circumstances are unfavourable, the mycelium inside the wood may grow for years, and destroy the tree, without ever showing any hymenium-bearing organs on the outside; in that case the fungus dies barren with the tree.

The genus *Trametes* comprises a number of species, particularly the *Trametes radiciperda* (R. Hartig), which settles upon the healthy roots of several varieties of pines, causes them to perish, and enter upon a process of decomposition which is termed the *red rot*.

The genus *Polyporus* (Frank), is so-called because it possesses a hymenium formed of many narrow, closely united tubes. Of these the *Polyporus fulvus* (Scop.), causes the *white rot* of the white or silver pine in the Black Forest, and the Vosges. The *red rot* of leaf-bearing trees, such as oak, walnut, pear, cherry, and poplar trees, is caused by the *Polyporus sulphureus*. Willows are also subject to a disease called the *white rot*, which is caused by the *Polyporus ignarius*, a species also dangerous to fruit-trees. This fungus is remarkable by the fact of its being perennial, lasting through many years, and increasing its fruiting body, which is attached to the willow, laterally, by a new layer of tissue every year.

Of the genus *Hydnum*, or *stickle fungi*, so called because their hymenium consists of many spines (like the spines of the stickle-back, the well-known object of the ambition of the juvenile angler), a species termed *Hydnum diversidens* (Frank), causes the white rot on oak and beech trees of the age of 80 to 100 years.

Of the genus *Thelephora*, a species surnamed *perdix* (R. Hartig), causes the *brown rot* of oak wood.

Of the genus *Stereum*, a species termed *Stereum hirsutum* causes the phenomenon called *moon-rings* of oak-wood, which is mainly caused by the mycelium remaining for a time confined to one or a few of the annual rings; these are at first brown, but become ultimately yellow, or even snowy white.

The *Agaricus melleus* is a large fungus of the mushroom type; its mycelium settles upon the roots of trees, kills the trees, and forms the fruit bodies on the base of the trees, just above the ground. The mycelium was formerly considered as a separate fungus, and from its attacks on the roots was termed *rhizomorpha* It occurs on many forest and cultivated trees, pines, larches, birches, beeches, particularly those which are between five and thirty years of age.

The vine also is liable to be infested by a particular variety of this fungus, which the French call *Blanc des Racines;* it has also been observed in the Vaudois, on the Lake of Constance, and on the Rhine. Chestnuts and apple trees also fall victims to this rhizoctonia, or related species. The chestnut trees in the Cevennes were in 1871 affected epidemically; they first showed single dead branches, then many branches died together.

In Richmond-park, on the height near the gate to Pembroke-lodge, stood a beautiful horse-chestnut tree, which for years was affected with a rhizoctonia, of which I cannot give you the species. It died two years ago, after having made a slight attempt to grow its spring leaves.

The present seems to me the proper occasion for directing attention to omissions which are made, or practices which prevail in private and public parks and forests, with reference to the toleration of parasites on trees. The superintendents of some of them, *e.g.*, of Hyde-park and Kensington-gardens, are, of course, well aware of the danger of the presence of a considerable number of infected trees in those parks. But when they attempted to remove the greater part and the worst specimens of them, there was a great outcry raised by ignorant persons, particularly in the public press. I specially inspected some of these trees, which were felled some time ago, and about which even members of Parliament asked questions in the House, and wrote letters to the public press. These trees were in part so rotten that I could pierce them with my

stick, and in some parts my stick, with no extraordinary force, entered the stumps to the extent of two feet. The existence of such trees was not even compatible with safety to the public, much less safety to the plantation. To spare rotten or fungus-invaded trees is the worst economy, because all healthy trees are thereby placed in constant jeopardy. No rotten or hollow tree should be allowed to exist in any plantation or park, and as regards our London parks, I should advise the immediate careful search for and removal of any trees or stumps falling under that category. Mutilated trees, such as have lost their tops or large branches, should be carefully trimmed, hollows coated and filled with cement, and all fissures made secure against rain water and the corrosive action of the dew from the London fog and smoke by means of tar or paint.

The *Discomycetes* belong to the division of *Ascomycetes*. The latter bear their name from the fact that their spores are formed in the interior of peculiar mother-cells, the so-called *asci*; now in the discomycetes these asci are united so as to form a disc-like organ; they should therefore be termed disco-ascomycetes. We may divide the parasitic fungi of this order, which cause diseases, into five sub-orders. The first sub-order are the *Gymnoasci*, the second the parasitic *Pezizas*; these must again be separated into two divisions, such as do not form sclerotia, and such as do form them. The third sub-order comprises the valve-scab, *Phacidium*; the fourth, the fissure-scab, or *Hysterium*; the fifth, the wrinkle-scab, or *Rhytisma*. The *Gymnoasci* have at least three genera. The first, *Ascomyces*, comprises two species, which live on *Alnus glutinosa* and *Cratægus oxyacantha* respectively. The second genus is *Taphrina*, of which the species *aurea* lives on poplars. The complete plant is a simple ascus filled with spores. The third genus is termed *Exoascus*, and is remarkable because a species lives upon the plum tree, and causes a peculiar malformation of the plums. The mycelia in the fruit push asci towards the epidermis, which stand close together, while some project over the surface. The Germans term the malformed fruit *taschen*, the French, *pochette*; in some parts of England they are termed bladder plums. The mycelium of the fungus is observed in the very young fruit and in the branch on which it grows, but the manner in which it penetrates into either is not yet ascertained. It has been surmised that the fungus might be perennial in the plum tree, and upon this assumption is based the advice, practically good, to remove all affected plums as early as possible, with the branch on which they grow, at the next branch bearing healthy fruit. A similar disease settles on peach and cherry trees, but affects the leaves only, not the fruit.

The parasitic Pezizas, which form no sclerotia, number at least eight species. Of these one, the *P. calycina*, frequently destroys large trees, by detaching the bark, and causing it to rot. This disease foresters term cancer of the larch. The other Pezizas live on wild plants, and only one causes a disease, characterised by little spots, on the ordinary clover. The Pezizas which do form sclerotia are at least twelve genera in number. These fungi are remarkable by the fact that the mycelium, after having grown in the host to some size, forms a hard lumpy mass, black outside, white inside, and without spores in the first instance; this *sclerotium* so-called is a lasting form of mycelium, as which the fungus reposes during adverse seasons. At the proper season it forms spores, which propagate the species. Of many genera the entire cycle of development is not yet ascertained. One species, *Peziza sclerotioides*, lives upon the rape or colza plant (the seeds of which furnish the colza oil), and destroys it; and after the host is dead, the Peziza lives in the dead matter as a saprophyte, forms ascospores, which then enter young plants by the spiracles, if they come in contact with them. A very dangerous Peziza lives upon clover, and destroys the plants; another upon hemp; a fourth upon onions; a fifth upon hyacinth bulbs; other Pezizas affect balsams, carices, the rice plant, grass, many kinds of fruit; the Pezizas act mostly very quickly and deleteriously upon their hosts, as if they secreted a poison and killed the cellular tissue by impregnation with it. Of the valve scabs, none are of practical importance; of the fissure scabs, *Hysteria*, two species affect pine trees; of the wrinkle scabs, *Rhytismata*, the most important species (out of four) affects the *Acer pseudoplatanus*; in the course of last summer such a tree in the bottom of my garden was completely bared of its leaves by the combined action of countless aphidia and wrinkle scabs.

Mildew in English, German *Mehlthau*, is derived from the appearance of the affected plant, which resembles in a measure a plant which has been dusted with meal. The later

Latins called it *Albigo*, and Linné first classed these formations with the fungi, under the name of *Mucor erysiphe*.

Of vegetable parasites, the mildews are, in a popular sense, best known. They are a form of *blight*, which has almost appropriated as a name this expression of an effect. They are confounded not rarely with the blight or mildew which, on closer examination, is seen to consist of myriads of shed skins of aphides, or green fly. This confusion is favoured by the similarity of effects, and by the fact that these animal and vegetable parasites not rarely live in dense masses, close together, on the same host.

The *mildew fungi, Erysiphes* (Hedw.) belong to the *Pyrenomycetes*, fungi which are characterised by very small spore-capsules, the interior of which consists of asci, although it looks like a homogeneous mass. They also possess various alternating forms of spores, and spore-bearers, namely, conidia and their bearers, spermogonia and pycnidia; the latter are a kind of spermogonia, distinguished from those commonly so-called by larger spores.

We know seven genera of mildews, comprising at least 30 species, existing on well-known phanerogamous plants. When it is considered that in Endlicher's "Synopsis of Plants" there were 40,000 species enumerated, that the number of species registered has doubled since Endlicher, that the orchideæ number about 10,000 species, it may be justly surmised, as a result of hypothetical generalisation, that not only mildews, but all parasitical forms of plants will be found nearly as numerous as the phanerogams themselves, and will therefore have to be counted by thousands; but of this vast subject we can only take summary notice.

The mildew of grass (*Erysiphe graminis*) exhibits the mycelium on the haulm, its conidia-carriers, and the spores detached, and ready for separation; this process of growth exactly imitates the growth of tape worms. A globular perithecium of another species, *Erysiphe communis*, has long supporting bristles.

I must abstain from enumerating the genera and species, particularly as this is the opportunity for insisting upon the fact that all mildew disease is directly curable. The best known mildew is the oïdium of the vine, known after its discoverer, the Gravesend gardener, Tucker, as *Oïdium Tuckeri*. It lives on the outside of the green parts of the vine, but

FIG. 11.

sends suckers, *haustoria*, into its tissue, and thus destroys its host. It has been found that the presence of sulphur in a finely divided state is fatal to the oïdium, and by the use of sulphur only have the wine-producing lands been liberated from this plague. Madeira was ruined by the fungus. In that island 10,000 butts of wine were at one time produced annually; a few years after the invasion of the oïdium no wine at all was produced in Madeira. Now the production is again considerable. In Portugal I have seen the vines of entire districts, such as Carcavellos, Bucellas, and others, destroyed by this calamity

Now the mode in which the fungus was destroyed was laborious, and yet imperfect. But the genius of a French gardener invented a machine for sulphuring, which is at once cheap, convenient, and efficient. It consists of an inner retort filled with water, and an outer

retort filled with sulphur, both fixed in a portable little stove, heated with charcoal. The coal fuses the sulphur and causes it to distil; the sulphur vapour causes the water to boil, and the steam carries the sulphur vapours with violence out of the cauldron. A man walking with this apparatus along the vines, as quickly as he can, and keeping about a yard away from them, will cover the plants in all their finest details with an exceedingly fine layer of condensed steam and sulphur. The process is perfectly beautiful, and one application is always effectual.

Now I propose that our agriculturists should apply this method to all kinds of mildews as they arise before their eyes, particularly on graminaceous—principally corn—crops, on beans, peas, vetches, and other leguminous plants, and on hops. This is the more to be desired, and the more profitable, because sulphuring is also a perfect remedy against several forms of the more destructive genus comprising the *fumagos*, or *soot dews*. These, as the name indicates, are mostly black when seen in mass; mildews, so called from their similarity to meal-dust or flour-dust, are mostly white. The word dew, of course, is derived from the supposition that the blight was a product of condensation of some matter which fell out of the atmosphere upon the plants like a dew.

The *soot dews*, or *fumagos*, are a genus of fungi which are mainly *epiphytes*, but not destitute of haustoria; these remain, however, superficial, so that some deny the existence of haustoria. The mycelia are thready, and cover the hosts as a fine dark to black layer, which can be removed not rarely in one mass. The fruits of the fumagos are of great variety, and as yet insufficiently studied. The spores take, *e.g.*, in the case of the fumago of the oak leaf, the shape of dichotomously branching chains of *torulae*, or of round raspberry-like masses of spores, *Coniotheria*. This process of the formation of torula-like spores is common to several fungi, and is called torulation; and the observation, no doubt correct in itself, led to the suspicion long maintained, and not yet finally negatived, that the torula of fermentation was only this spore form of a variety, perhaps a great number, of epiphyte fungi.

The fumago settles upon the upper side of leaves, and attains full development only late in summer. It is sometimes disastrous by spreading to cultivated plants from wild or forest trees. I know a case in which a splendid public garden on the continent was greatly troubled. The plants from the conservatories, which cannot endure the full summer sun, had been placed under the partial shade of lime trees; these became covered with soot dew, and very soon the plants beneath. When these had been removed and cleaned, an enormous labour, the soot dew sufficiently survived in inaccessible places to enter into the conservatories, and develop during autumn and winter. All plants, without exception, were affected in some degree, palms included, and it was only by a great effort and at great expense that the epiphytism was at last exterminated.

Even when the fumago does not send haustoria into the tissue, it is disastrous to the leaf on which it settles. Its position on the upper side of the leaf, and its dark dense tissue more or less diminish, and not rarely entirely exclude the rays of light from the leaf, and thus prevent the chlorophyll from acting in its specific manner. The synthetic chemistry and photo-respiration are at once arrested, and growth ceases. And thus the entire economy of the invaded plant is interfered with or destroyed.

There are fumagos which are of great importance in agriculture, such as the one living on hops; mulberry, lemon, and orange trees (*Fumago citri* (Pers.), *Apiosporium*, the disease in Italy termed "mal di cenere," ash-sickness); coffee-trees (termed "Kole roga," or "black mould," in Hindostanee); *Pellicularia koleroga* (Cooke). Against this latter Cooke has also very properly recommended sulphuring as an antidote or fungocide. Fumagos also live upon the pine, one spore-form having been termed Torula pinophila.

We have yet to consider an order of *endophytic parasites*, which are characterised by possessing conidia bearers, and produce a kind of phenomenon recalling the appearance of fumagos. The first genus includes the *pleosporas*, of which some are mere saprophytes, others true parasites, like the Pleospora oryzæ, which causes the rice-brand, in Italy termed "Brusone," or "Carolo del riso." Amongst the nine species of this genus we count fungi living on maize, rape, carrots, and beetroots, and the Pleospora of the potato, causing the frizzle sickness, already described in the first lecture, and distinguished from the potato-murrain caused by the Phytophtora.

The second genus of fumagoid conidioferous endophytes is termed *Fusicladiaceæ*; the seven species known invade apple-trees, and cause

the projecting rust spots on apples, of which few only are free; pear-trees and pears; here not rarely termed "scab;" and cherry and other trees.

The third genus has only one species, *Polythrincium trifolii*, which causes the black sickness of clover.

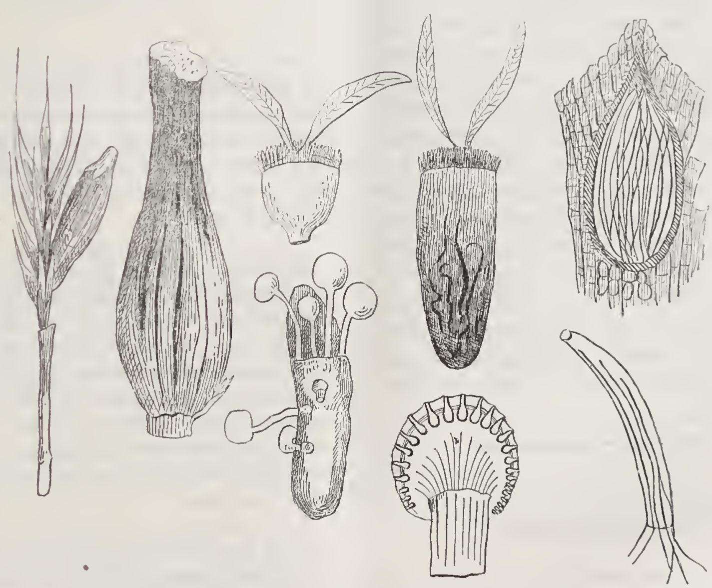
The fourth genus comprises the fungi which produce a variety of leaf spots, and send their conidia carriers out of the spiracles or breathing holes of the nether side of the leaves. Five subgenera must be distinguished—*Ramularia, Cercospora, Cylindrospora, Isariopsis, Scolecotrichum*. These have more than sixty species living upon cultivated and wild plants. The fifth subgenus is *Mastigosporium*. A sixth subgenus, *Glœosporium*, includes the cause of a severe chronic affection of the vine called in France, *Anthracnose*, pitch disease, or black brand, *Sphaceloma ampelinum*. The subgenus counts at least twenty species. The seventh subgenus is termed *Fusisporium*; it includes half-a-dozen species, amongst them a saprophyte mould, common on fruit of all kinds in summer-time.

A division of leaf spot fungi is characterised by possessing spermogonia or pycnides in the spots on leaves or fruit. The five genera are named *Depazea, Ascochyta* (syn. *Phyllostyeta* (Pers.); *Dilophospora, Septoria, Phoma*. There are 30 species known.

Some *Pyrenomycetes* are the cause of tumors in the wood of forest or cultivated trees; other fungi of the same order settle upon the roots of various plants and destroy them, hence termed by De Candolle, *Rhizoctonia*. A species of this kind is destructive of entire fields of lucerne (*Medicago*). A third group of pyrenomycetes are termed compound, and include many genera, amongst them the parasitic ones *Phyllachora, Polystigma, Epichloe, Nectria*, and *Claviceps*.

The last word designates a species which is of *the greatest utility to mankind by its*

Fig. 12.



qualities as a medicine. Claviceps, from its colour, is surnamed purpurea, or ergot of rye. When neglected and allowed to mix with the food of man, it acts as a poison, and produces the cribble-sickness. This disease has occurred in the form of epidemics in rye-consuming countries during three centuries ending in 1850. But the medicine, *Secale cornutum*, is most useful in various conditions of the human frame, *e.g.*, hemorrhages, particularly those which are incidental to the female reproductive organs. The drug, or its extract, acts as a stimulant of the contractile activity of the uterus, and is by that effect really a specific in protracted labour of childbirth.

The fungus has two kinds of spores; the one kind is formed on the invaded corn, or grass-blossom, before the sclerotium has appeared, and is able to transfer the disease

to other neighbouring plants; the other kind of spores is formed in particular fruit capsules which grow on the sclerotium when it lies on the ground after the harvest. The latter reproduce the fungus in the following spring. The fungus consists at first of hyphæ, which then become numerous, fuse together, and form a solid fungus, which at one time was termed *Sphacelia segetum* (Lév.) The body of the fungus is even now termed sphacelia. By its nature and function it is a *sclerotium*, *i.e.*, a resting form of the fungus in which it passes through the winter. (The work of Tulasne on "Claviceps" belongs to the glories of literature.) In the "British Pharmacopœia" it is termed *Ergota*. It is used as extract, infusion, and tincture; of the unprepared powder, 20 to 30 grains constitute a medical dose.

Fungi have a remarkable chemical constitution which has given rise to many researches by Braconnot, by Reinke and Rodewald, and many others. But of the specific products of the fungi, the poisons or medicines, very little is known. They contain 70 per cent. and more water; glykogen, identical with animal, has been found; sugar; asparagin; peptonising ferments; phosphatide (in spores); protoplasma; stroma; ash. The total protoplasma of a hymenomycete (æthalium) contains about carbon 40·5 per cent., hydrogen 6·2 per cent., nitrogen 5·7 per cent.; paracholesterin; normal cholesterin; terpen; volatile fatty acids, butyric, caproic, acetic, formic; fixed fatty acids; an acid like stearic, fusing at 69·4, but containing more carbon; oleic acid (?); stearic acid fusing at 58°; colouring matters; sarkin, guanin, xanthin; vitellin, plastin.

Miscellaneous.

MECHANICAL EQUIVALENT OF HEAT.

Mr. E. A. Cowper and Mr. W. Anderson have just submitted to the Mechanical Section of the British Association, the results of a very large first experiment to determine the mechanical equivalent of heat, which give an interesting and almost exact confirmation of Professor Joule's experiments. The principle adopted was to have an apparatus always in a normal state, and using a large amount of power, viz., about 5 h.p., and of course producing a large amount of hot water, viz., about a gallon a minute raised about 20° Fahr. The machine used to absorb power and produce heat was one of the late Mr. Froude's dynamometers, and the way in which any loss of heat to the surrounding air was avoided was by letting the hot water run into a small tank that enclosed the dynamometer, and so surround the machine with water of its own temperature; this hot water then ran into another larger tank outside the first one, and so surrounded it with hot water, and its temperature was kept to the same as the issuing hot water from the machine by a small steam pipe. The outer tank was of thick wood, and had three coats of hair felt outside it. The results obtained on a three hours' trial was 769 as the mechanical equivalent of heat; it will be remembered that Professor Joule's last experiments gave 772 as the equivalent.

General Notes.

Indian Tea.—A meeting of tea brokers and dealers has been held to settle the question of raising the limit number of packages for small or now sampling breaks. It was decided that after the 5th inst. the limit of small breaks should be—*Indian*, 12 chests; 18½ chests; 30 boxes. *Ceylon*, 12 chests; 12½ chests; 30 boxes.

Manufactures in Roumania.—According to the *Deutsche Handelsarchiv* a legislative measure has been adopted in Roumania for the promotion of manufactures. Amongst the advantages offered to those contemplating the erection of industrial establishments, are free grants of sites upon state and municipal lands, immunity from all direct state, district, and communal taxation for 15 years, and the admission, free of duty, of the necessary machinery and raw materials.

Glass Manufacture in Norway and Sweden.—The manufacture of bottles has (according to the *Sprechsaal*) made considerable progress of late years in the above countries. The article made is said to be good and clear, and to be making an active competition in England against home-made goods; the lower price of labour and other advantages bringing the Scandinavian article at about half the price of the English product. Fuel is cheap, many of the Swedish glass manufacturers being, at the same time, wood dealers, and the refuse from the saw-mills being available for the glass-making. The cost of living in Sweden is said to be lower than in any other country, and the condition of the workpeople is considered to be good.

Journal of the Society of Arts.

No. 1,817. Vol. XXXV.

FRIDAY, SEPTEMBER 16, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

The Council of the Society of Arts have determined, on the recommendation of the Committee of the Applied Art Section, to offer prizes to art-workmen under the following classes:—

1. Prizes are offered to Art-workmen in certain classes of Art-workmanship enumerated below. These prizes will be awarded to workmen only, and the work must have been executed in the United Kingdom or its dependencies.

2. The objects submitted for competition may be the work of one workman, or of several workmen working in combination. They need not necessarily be the property of the workman or workmen sending them in. Manufacturers or employers may exhibit articles on behalf of their workmen. In this case, besides the name of the manufacturer, the names must be given of all the workmen who have executed portions of the work, with a statement of the portion executed by each. If any prizes are awarded they will be given to the workmen, and a certificate, enumerating the award or awards, will be given to the manufacturer.

3. The objects in each class may be:—

(i.) Copies of existing works.
(ii.) Modifications of existing works.
(iii.) Original works.

4. In awarding the prizes, the judges will take into account the following points:—

1. Originality or beauty of design.
2. Fitness of treatment.
3. Excellence of workmanship.

5. Before the award of prizes is finally made the candidates must be prepared, if called upon, to satisfy the Council of their competency.

6. The works will remain the property of the competitor, or of the person from whom he has borrowed them for the competition.

7. Although great care will be taken of articles sent for exhibition, the Council will not be responsible for any accident or damage of any kind.

8. Prices may be attached to articles sent in and sales made, and no charge will be made in respect of any such sales.

9. All the prizes are open to male and female competitors on equal terms.

10. When two or more workmen combine in the production of any article sent in for competition, the names of, and the respective parts taken by, each must be specified when the article is sent in, and the proportions must be stated in which they may have agreed, if successful, to divide any prize which may be awarded.

11. All articles for competition must be sent in to the Society's House on or before Saturday, 3rd December, 1887, and must be delivered free of all charges. Each work sent in competition for a prize must be marked with the workman's name, or that of the manufacturer, or, if preferred, with a cypher, accompanied by a sealed envelope giving the name and address of the workman or manufacturer. With the articles a description for insertion in the catalogue should be sent. The works will be exhibited at the Society's House, or, if the necessary arrangements can be made, at the South Kensington Museum.

12. The Council reserve the right of withholding any of the specified prizes, or of substituting smaller prizes, or varying in any way their respective amounts. Silver and bronze medals may also be given at the discretion of the judges.

Prizes are offered in the following eight classes for the present year as follows:—

1. Painted glass, £25, £15, £10.*
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other

* Objects sent in for competition in this class must not exceed fifteen feet superficial. In the case of large works, a portion only (sufficient to give an idea of the whole work) need be sent.

material, with or without engraving, £25, £15, £10.

5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.

6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.

7. Hand-tooled Bookbinding, £25, £15, £10.

8. Repoussé and chased work in any metal, £25, £15, £10.

Proceedings of the Society.

CANTOR LECTURES.

THE DISEASES OF PLANTS, WITH SPECIAL REGARD TO AGRICULTURE AND FORESTRY.

By J. L. W. Thudichum, M.D., F.R.C.P. Lond.

Lecture III.—Delivered February 7th, 1887.

Diseases of Plants Produced by Animals.

All vegetation is a prey, firstly to parasites of its own kind; secondly, to animal parasites to be considered in this lecture; and thirdly to the herbivorous animals, including man. The herbivores occasion no doubt great destruction, and all manner of wounds to plants, some of which open the door to disease-causes formerly considered. But their ravages have no place in our programme, however specific some of these may appear to be.

The true animal parasites of plants are those which derive a lasting interest from the continued, though altered economy of the invaded host, and by abstraction of nutriment, or diversion of circulation, and the production of mechanical malformation, destroy its integrity and health. Then the parasite produces atrophy, causes the cell-contents, the protoplasm to shrink, the chlorophyll to pale, and ultimately the whole plant to die. In most cases the plant reacts in the first instance against the parasite by increased action, a mode of defence we have already seen is adopted by some plants, *e.g.*, the thistle, also against vegetable parasites, in this case the *Puccinia suaveolens.* This increased action results, in the case of animal parasites, mainly in *local hypertrophies,* produced by a multiplication of cells, which overgrowths assume peculiar forms, adapted to the residences of the parasite or its offspring, forms which in their generality are termed *galls,* or botanically *cecidia* (κηκίδιον, diminutive from κηκίς, a gall). To distinguish the galls produced by parasitic plants from those produced by animals, the former have been termed *phyto-cecidia,* the latter *zoo-cecidia.*

In some galls, as in those of oak-trees, we observe the chemical action of the cells of the host exaggerated, *e.g.*, in the production of tannic acid. In all we observe an influence exercised by the parasite, which ceases with the death or disappearance of the parasite. The nature of that influence, exercised firstly in the production of overgrowth at all, secondly in giving to that overgrowth a shape conducive to the welfare of the parasite, is a mystery, which can be solved as little by teleological speculations as by evolutional assumptions. On this subject, as on the whole range of parasitic phenomena, particularly those exhibited by diseases of the human race, further inquiry remains the watchword.

Ehrenberg, who made so many deeply philosophical microscopical discoveries, illustrated them in the highest style of art, and described them in classical language, was the first to discover a gall on the threads of an alga, *Vaucheria,* caused by a *rotifer,* the *Notommata Werneckii.* The gall is a regular nest, containing a female with numerous young and ova.

Of *the class of worms* which has such numerous representatives amongst the parasites of animals, particularly those which live in the intestinal cavity of their host, only one genus, belonging to the *nematodes,* or *round worms,* is represented. Some, not very well described, occur on the roots of beets, and have somewhat sensationally been termed *beet-root trichinæ.*

Of the microscopic nematodes termed *eels* (*anguillulæ*), of which some species living in vinegar and in paste are well known, several species live in different parts of different plants, and produce very remarkable galls.

Thus the *wheat-eel* (*Anguillula tritici*) lives in the ear of wheat, which it mostly

destroys entirely. A wheat-corn thus affected is about half the size of a healthy grain, has a blackish-brown colour, and a very woody shell.

FIG. 13.

It contains a whitish, finely fibrous matter, which under the microscope is seen to consist of nothing but an interwoven mass of densely-packed anguillulæ. One wheat-grain gall contains several thousands of these parasites. As long as the gall is entire, they are motionless and apparently lifeless. When the grains are kept dry, the animals remain in this state of trance for several years, up to twenty-five years, and can then, under proper conditions, assume their active life. This ensues when the grain containing them is sown in the ground. The capsule bursts, the eels crawl out, and search for their natural hosts, namely, the young wheat plants. In doing so they travel through distances which are a foot away from the spot in which they crept out of their original gall. Arrived at the young wheat plant, they settle between its blades, rise with the stalk, and, at the time of blossoming, penetrate into the stamina and fruit capsule. These now turn into galls. In these galls the previously sexless anguillulas assume sexual perfection and couple, the females lay eggs and die. The eggs are hatched and remain coiled up in the galls as asexual parasites, which then resume the cycle above described.

The *rye-eel (Anguillula devastatrix)* Kühn, lives on rye and other cereals, and settles in the internodes of the young haulm, and the bases of the leaf sheaths. It causes either atrophy or the death of the entire plant. The root-eel (*Anguillula radicicola*) causes small galls on the roots of some varieties of gramineæ and crassulaceæ.

An anguillula is very dangerous to coffee-trees in Brazil, as it spreads radially from a centre over great areas, and devastates entire plantations, particularly those between seven and ten years old. The galls or nodosities on the smallest roots are only of the size of a hemp seed; each contains in its cavity either eggs or hatched worms, to the number of 50 or 60. These eels perish by drought.

Mollusks devour much vegetable matter, living and dead, but are not parasites causing disease. Amongst the *articulates*, however, we find the greatest number of parasites here to be considered.

The *red spider* (*Tetranychus telarius*, L.) stings the leaves of many plants on the under-side, in consequence of which they become yellow, inactive, and drop. Hops are very liable to be infested.

Another genus is termed *Phytoptes* (formed after *Sarcoptes*)*; it is an *acarus*, with only two pairs of legs, two pairs remaining rudimentary. These animals live in galls of buds only, nourish themselves by suction, and propagate by eggs. They are of microscopic smallness. They migrate from the old galls which die in summer to the newly-formed buds, and reproduce small galls in them, where they winter. In spring, the galls attain their full size, and the acari multiply and emigrate. Many of the acari, and the galls which they produce, have yet to be identified. The galls are of various kinds, which have been classified as follows:—

1. *Felt-disease of Leaves, Formation of Erineum.*—Persoon believed these outgrowths to be fungi, and after him many botanists did the same. Unger, in 1833, was the first to recognise that they are epidermoid outgrowths of the plants themselves, and not parasites. Fée, in 1834, first saw the acari within them, and declared them to be the causes of the outgrowths. The nature of the outgrowths is best understood by reference to Fig. 14 (p. 924).

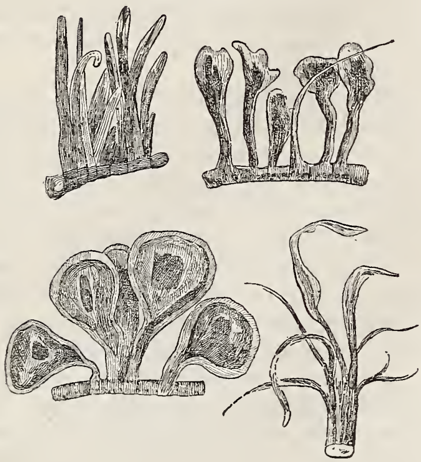
The best descriptions of the acari of erineum were given by von Siebold in 1850. The greatest number of their numerous genera and species were discovered between 1850 and 1870.

These grotesque felt-forming outgrowths are mono-cellular formations, starting from the mesophyll, and covered by an epidermic layer. Under their shade and protection (not within them) live the acari. Water never penetrates into the interior of these forests, particularly where they are on the under side of the leaf.

* Properly *Sarcocopta*, flesh-cutter, name for the itch-acarus; *Sarcoptes* is also frequently used, though less correct; *Phytoptes*, also written *Phytoptus* by several systematic writers, should be *Phytocopta*.

In the parts of the leaf bearing the felt, the chlorophyll becomes less, or it disappears from them; new colouring matters are deposited—red, blue, and yellow. Old walnut trees are sometimes covered with "erineated" leaves. It is necessary to collect all leaves as they fall and burn them, for the acari winter in the galls and ascend the trees in spring. A great number of erinea on more than a score of well-known plants have been described.

FIG. 14.



2. *Pocket Galls, Sack-like Galls, Kephalonea,* are also produced by the sting, presence, and mysterious influence of acari. The outgrowth forms a solid bag, within which the acari live. The interior of the bag and its aperture, not rarely also the outside, are covered with hair-like hypertrophies of the erineum kind. The pocket galls mostly project on the upper side of the leaf, and have their entrance on the lower side. The growth begins immediately after the leaf has left the bud.

When the acari do not get room on the leaves they descend sometimes to leaf-stalk and branches. There, not pocket galls, but flat cups only are produced, in the bottom of which the animals reside. This condition has been termed a *dimorphism* of the galls, but is more an atrophic modification than anything else.

3. *Rolling and furling of leaves,* with or without thickening of the substance of the leaf, frequently occur, and is caused by particular species of acari, belonging to the genus phytoptes. It has been specifically observed and studied upon many scores of genera of plants.

4. *Crippling and dwarfing of leaves* goes sometimes to such a degree, that the affected leaves cannot be recognised as those of their parent plant *(e.g., Pimpinella saxifraga).*

5. *Tumefaction and hypertrophy of buds.*

6. *Phytoptes* living within the substance of the leaf, cause merely a tumefaction like a pock; this disease on the pear tree has been termed *pear pox.* It is an attempt at the formation of a κηκίς—a gall—but ends in mere tumefaction with a small cavern inside.

Of *Insects,* the *Hemiptera* require our attention for a moment. I believe that the injuries which *bugs* do to cultivated plants are not sufficiently recognised. As an example, I may cite a green bug, a kind of *Strachia* (sp. ?), which annually destroys in my garden many buds and leaves of dahlias. Its presence is recognised by minute brown spots on the buds and earliest branches, the result of the stinging of the animal. Every stung part dies, and the leaf, therefore, becomes pierced like a sieve, and remains misshapen. I search for the animal (there being rarely more than one on a bush in high summer) by opening the young leaves. The animal then rushes out, and, like the bull before tossing, or the partridge after the first rise, stops for an instant. Then is the time to seize it. If it makes a second move it is generally lost to sight in an instant, and, once disturbed, never returns to the same dahlia plant. It has a distinct mint-like smell, less strong than the large coloured strachias on raspberry and other bushes.

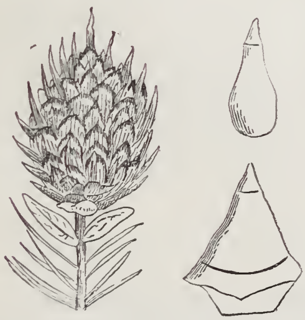
Next to the bugs we have to consider the *cicadas,* which injure corn, vines, roses, and other ornamental flowers. The *froth cicada* (*Aphrophora spumaria* L.), bears its title from the froth which it secretes, and in which it lives. Its sting causes the leaves affected to become crippled.

The *jumping lice, vegetable fleas* (*Phyllodes*), are a family of several genera; they have wings, but prefer jumping. Eight species are diagnosed.

The *aphidia,* or green fly, are too well-known to require much description. They sting the plants, and live upon their juices. Their course of life begins in spring, with *wingless females,* which give birth to live young, or lay eggs which soon evolve young. All these animals are again wingless females, which produce, *parthenogenetically,* living offspring. This mode of reproduction may continue for several generations. The last generation produces eggs only, male and female; these are matured, and produce males and females, which now couple. The females lay eggs,

which either produce the spring-female already in autumn, so that it hybernates; or last through the winter and produce the spring-female in spring. The aphides secrete the honey-dew, which is similar to that secreted by plants upon which they live. It is most sought after by ants, of which aphides are, therefore, termed "the milch-cows." Boussingault showed that this honey of plants and aphides contained two kinds of sugar, cane and fruit-sugar. The aphides produce a variety of pathological changes on the plant structures which they sting, namely, yellowness and dryness terminating in atrophy, and galls, the result of irritative hypertrophy. There are more than thirty species of aphis known, of which about thirteen produce peculiar galls, that must not be confounded with the galls produced by certain species of acarus or phytoptes. The aphis galls are produced by the bending, rolling, or folding of leaves, and by the formation of pockets, whereas the phytoptes galls are the result of the deformation of the points of branches. Such a deformity is produced on the points of abies by *Chermes abietis*. The figures on the right are representations of deformed needles.

Fig 15.



Another fourth variety of aphides live on the rind or bark of plants, and produce by their stings and irritation a condition of the vegetable tissue called, popularly, "cancer." The most common example of this is the *blood louse*, or *woolly louse* of apple trees. It is very dangerous to trees in this country, and in a garden which I formerly cultivated, it destroyed all apple trees, notwithstanding great care which was expended on their preservation.

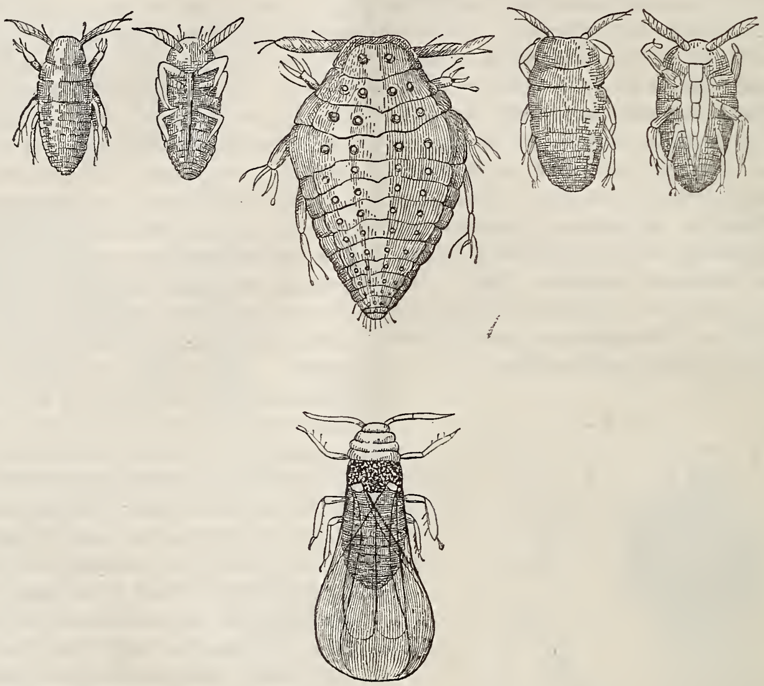
Of the aphides producing galls on roots, the most celebrated and dreaded is the *Phylloxera vastatrix* (Planch.). This insect was discovered to be the cause of the most destructive vine disease by Planchon, in 1868, after the disease had ravaged may vineyards since 1863. Asa Fitch had previously discovered an insect which produces leaf-galls on the vine, and which is now known to be reared out of the early egg of the winged female of the phylloxera, which does not hybernate. It was only by long studies carried on by many inquirers that the complicated life history of the phylloxera in its many stages was fully found out. This life history is the following, if we start with the golden-yellow, wingless female, the large, spotted creature of Fig. 16 (p. 926). This female lays thirty to forty eggs, out of which the young creep in about eight days. Each of these now begins to multiply by parthenogenesis, and may produce up to eight generations in one summer. One female may therefore have a parthenogenetic progeny of 30 millions in one summer. They all remain on the roots on which they have been produced, and by stinging them produce galls and nodosities. The last brood at the end of summer, termed nymphs, or pupas, have beginnings of wings. These creep out of the earth, shed their skin several times, and become fully winged individuals. Their wings are four in number, large, and when the animal is in repose, lie flat on the body, as shown in Fig. 16 (p. 926). These winged nymphs now fly, and deposit eggs upon vines in the air; these eggs are four in number, and of different sizes; the larger eggs yield wingless females, the smaller eggs wingless males. These now couple, whereupon each impregnated female puts down one large winter egg in the crevice of the bark of the vine. In spring this egg developes to a wingless female, which descends to the roots, and propagates by parthenogenesis, as above described.

From a communication to the press by Mr. D. Watney, which summarised the ravages by the phylloxera, it appears that for the four years from 1875 to 1878, inclusive, the average yield of the French vintage was 1,275 million gallons. The last three vintages, 1882 to 1885, have decreased at a greater rate than 100 million gallons a year, so that the production of wine in France has fallen to little more than half of what it was before the spread of the phylloxera. The animals can be destroyed as yet by only one remedy, namely, inundation, begun in November and continued for forty days. This was proved by M. Faucon at Mas-le-Favre, near Avignon. He produced, in 1867, 925 hectolitres of wine in his vineyard; in the next year

the invasion of the phylloxera took place, and he harvested only 40 hectolitres; in 1869, 35 hectolitres. The vineyard was now inundated with water from the Durance canal, which supplies Marseilles with water. The yield of the vineyard thereupon rose to 120 hectolitres, and has increased every year until it has attained its former high figure.

Where inundation is impossible, the viticulturists rely upon sulphide of carbon as an insecticide. This fluid is forced into the earth by means of an injector, and is said to produce good results. A Commission appointed to study the question publishes frequent reports. Most States in which wine is grown have made laws against the importation of vines from countries in which the phylloxera prevails. But considering that the animal has an aerial period of existence, during which it can with enormous wings fly over many miles of country, these measures seem useless, at least for the protection of contiguous States.

Fig. 16.



The shield lice, or *coccina*, sting the plants and suck the juice, many without changing place. They secrete honey dew and waxy matter. The best known of this family is the *Coccus cacti*, or *cochineal insect*, which yields the celebrated dye; this is a product of the economy of the animal itself. A shield louse living in the East Indies, *Coccus lacca* (Kerr), pricks certain species of ficus, and these in consequence exude the substance termed gum-lac; this by purification becomes stick-lac, and ultimately shell-lac, much used in manufactures, and the base of sealing-wax. Another shield louse has been described as living on *Tamarix gallica*, var. *mannifera*, a plant common in the Sinai mountain, and causing it by its sting to exude a kind of manna. For this reason Ehrenberg called the animal *Coccus manniparus*. Another member of this family is the *vine louse* or *vine bug*, *Coccus vitis*, common in England on the vine, particularly the older wood which is covered by loose bark. Besides the three species mentioned, there are five or six further species known, which live on different plants, not a few in conservatories. Some are known to produce the changes called cancer by gardeners, and others give rise to galls.

Of the *Orthoptera* the grasshoppers claim our attention for a moment as direct destroyers of vegetation. The *locust* (*Oedipoda migratoria*, L.), and its Ægyptian and Tartar cousins produce the dreaded destruction of crops, of which history relates so many remarkable examples. These animals can be combated mainly by the destruction of their eggs. The

mole cricket (Gryllotalpa vulgaris, Latr.*)* also causes some plants to sicken while living on others. The Spanish variety is very voracious, and makes raised passages like the mole; it is also very noisy, and continues its peculiar shriek for many hours, up to twelve, uninterruptedly.

Flies, or *Diptera*, are a very frequent cause of diseased conditions of plants. There are flies which sting the leaves, and thereby cause them to *roll in*, or which place their larva on leaves, and then causes them *to curl* so as to form more or less regular tubes of rolls. Of such cecidomyas not less than 18 species are known. The larva of one species produce *bags on leaves* (*Cecidomya bursaria*). *Galls on leaves* are produced by the larvæ of at least twenty-five species of cecidomyas. It is not known whether the fly, in placing the egg or eggs, stings the leaf, and places the egg inside the tissue, or whether the larvæ, having left the egg, bite their way into the tissue. *Deformities of new branches*, of points of vegetation are produced by more than 23 species of cecidomyas. Less frequent are those which produce *deformities of blossoms*. *Deformities of buds* are produced by 19 species; *thickening of stalks* by nearly twenty species, all acting as larvæ. Of larvæ which *mine in leaves* we know two species, of such as *mine in roots and stalks*, and erode passages we know at least 6 species. Amongst these is the *Anthomya Brassicae*, which is very injurious to turnips in Scotland. Agriculturists believe that liming the land in autumn is a good preventive of this plague. Of larvæ living in *sheaths* and *leaves* of gramineæ the most dreaded is that of the *Hessian fly*, *Cecidomya destructor;* it destroys corn-crops by eating into the stalk, which then breaks and falls to the ground. Of this genus 7 species are known. Of larvæ living *on the surface of leaves*, 3 species have been identified.

Of *Hymenoptera*, or *skin-winged insects*, the gall wasps or cynipida are the most remarkable. Their larvæ are maggots without legs. Of *oak-gall maggots* alone we know 33 species, which could hardly be described in a lecture for the purpose. Of *rose-gall wasps* there are 5 species, of similar inhabitants of other plants 10 species known. Of *leaf and wood-wasps* we know a considerable number. Thus of the genus *Nematus* which occurs on willow leaves, we have 3 species; of wasps whose larvæ eat leaves, 19 species; of wasps whose larvæ spoil fruit, 2 species; of such as live in the interior of branches, which they excavate, 3 species; of *wood wasps* which prefer forest trees a variety.

Amongst the *Lepidoptera*, or *butterflies*, there are 7 species, whose caterpillars form galls; of a vast number of species, the caterpillars eat leaves. They may multiply in favourable seasons to an indefinite extent, and become destructive to wild or cultivated vegetation. Thus the Nun, *Liparis* or *Bombyx monacha*, of which 6 species are known, has repeatedly destroyed entire pine forests.

Of *beetles*, *Coleoptera*, many produce eggs and larvæ which cause galls on many plants. Of such, at least 13 species are known. Many destroy roots, such as the larvæ of *Melolontha vulgaris*. The destruction caused in all kinds of wood by beetles and their larvæ is so manifold as to be indescribable.

Thus I have, within the frame allowed by the time allotted to me for these lectures, given you a rapid survey, a concise bird's-eye view of the entire subject of vegetable diseases, particularly those caused by parasitism. I cannot sufficiently urge upon agriculturists and horticulturists to make themselves thoroughly acquainted with the life history of all these enemies of their success. For most of these disease-causes can be suppressed only by attention to detail, bestowed permanently and at the proper seasons, and such care can only be successful if it is guided by complete knowledge.

Miscellaneous.

INHABITANTS OF THE GOAJIRA PENINSULA.

Consul Plumacher, of Maracaibo, in his last report, says that the peninsula of Goajira, which forms the extreme north-western part of Venezuela, is chiefly remarkable for its entire abandonment into the hands of the Indians of the same name, who have succeeded, up to the present day, in preserving their absolute independence, recognising no authority except that of their own chiefs. They are divided into different clans or tribes, all, however, being of the same race, with similar language and customs, and the different divisions now existing are developments of individual families of the same general stock. The Venezuelan Government has contented itself with placing a military post on the frontier for the protection of the

whites who, attracted by the fine grazing country, have established cattle farms and small settlements in the neighbourhood. In spite of this precaution, the Indians at times combine in numbers of several hundreds and make a raid into the civilised territory, retreating to their own domain with their plunder. The Indians know but little of agriculture, but engage largely in the breeding of cattle. Maize and vegetables are cultivated on a small scale, and cotton, which grows wild in some localities, gives exceptional returns when any attention is paid to its culture. The women spin their own yarns, and with rude hand and foot looms weave a substantial fabric, of which they make hammocks and other articles, which are dyed in various colours by peculiar earths and the juices of trees and plants. The customs of the Goajiras are singular and interesting, and it is noticeable that their laws and usages have remained without change from time immemorial. One of their most striking customs is a complicated system of what is called by them "payment of tears and blood," and this is the principal cause of conflict between the clans. Among all savages revenge is a sacred duty, and as, according to Goajira ethics, an entire tribe is supposed to be responsible in the aggregate and individually for the acts of one of its own members, a trifling affair in the beginning may produce grave consequences ultimately. This is one of the reasons why it is dangerous for white men to enter the Goajira territory, as the Indians make no distinction of nationality, but consider all who are not of themselves as belonging to one great family, all the members of which are responsible for a real or fancied outrage committed by an individual, and any of whom are to be considered to a certain extent as a hostage for the conduct of the rest. By the payment of the compensation of tears and blood, any injury inflicted may be condoned, it being noticed that it is not the aggrieved individual who demands this payment, but his relatives, especially those on his mother's side, who are supposed to be of a closer relationship than the family of his father. If an Indian accidentally wound himself, break a limb, or meet with any similar accident, his mother's family immediately demand of him the "payment of blood," on the theory that as his blood is also their own, he has no right to shed it without making compensation. The relatives of the father also claim the payment of their tears which is of less value. Even the friends who may have witnessed the accident are entitled to compensation for the grief into which they are plunged at seeing their companion suffer. The amount of the payment depends upon the character of the injury. A trifling cut of the finger calls for a little corn, a kid, or something of equal value, and if the matter is more serious, nothing less than a goat or sheep, or perhaps a cow, can assuage the sorrow of the sympathising relatives. If the injured party is too poor to satisfy these demands, he must go begging from hut to hut, and no one will refuse to contribute his mite to assist in the performance of a recognised duty. If an Indian borrows a horse from a friend, and is thrown, or in any way injured, his relatives demand compensation from the owner of the animal, alleging with undeniable logic that the accident could not have happened had he not lent it. In case a person is injured by his own animal, he himself must compensate his relatives accordingly. General responsibility is of daily occurrence, and may happen in various ways. For example, the seller of any article is responsible for the results which may follow from its misuse. For this reason, traders penetrating into the interior do not carry rum for traffic unless they are strong enough to defend themselves and their property, as should compensation for the results of over-indulgence be denied, the Indians would consider themselves justified in seizing whatever they could lay their hands upon. In these complicated laws of compensation, strict justice is not always considered, as if a person should be wounded, or lose his life while attempting to kill another, the latter must pay "blood and tear" money in the same manner as if he had been the aggressor. To such an extreme is this system carried out that should a child die in the absence of one of its parents, the latter can demand from the other payment for the tears supposed to be shed over the occurrence. The ceremonies attending marriage are as follows. As soon as a girl reaches a marriageable age she is shut up alone in an isolated hut, deprived of all ornaments, and dressed in a long white gown. During the first few days she must not drink water, sustaining herself only with a composition of medicinal herbs called *haguape*. She is then publicly spoken of as *surtirse surupauru*, the literal translation of which is "shut up in the house." The duration of this retirement varies according to the position of the family, and when an eligible suitor demands her hand, she is usually at once released, a grand family feast is held, and she is then considered as married without further ceremony except the payment of her stipulated price. This consideration generally takes the shape of cattle, divided between the father and other relatives of the bride. The woman is then obliged to maintain her husband in food and clothing, and is the principal in all matters of business, no bargains made by a man being considered valid unless it has received the sanction of the wife. Upon the death of the husband the wife becomes the inheritance of one of the brothers, usually the youngest, and if there are no brothers, of the nephew. The ordinary dress of the Indians is simple, and in the case of the males consists of a cloth around the loins, and a plaited grass ring upon the head, but on occasions of ceremony they appear with handsome cotton mantles of variegated colours, and head-dresses of feathers. The dress of the women is a voluminous gown, made like a bag, with apertures for the head and arms. The ornaments most esteemed are collars, necklaces, and bracelets of beads, which are used with great prodigality. These

are for the most part of foreign make, but the most valued are the *tumas*. These are roughly shaped reddish stones, perforated for stringing, and comprising varieties of jasper, onyx, cornelian and agate, and are apparently of great antiquity, having been handed down from generation to generation from long before the Spanish conquest. The traditional arms of the Goajiras are bows and arrows, and although they are plentifully supplied with fire arms they still cherish the weapons of their ancestors. Of these arrows there are three classes—the *hatu*, pointed with a sharpened nail or hard wood for small game, such as birds and lizards; the *siquarrai*, with barbed iron points made of knife blades and used both in the chase and in war; and the poisoned arrows called *aimara*, about 3 feet long, and pointed with the spur of the sting ray dipped in an active poison made from putrified animal substances in the following manner. Dead toads, snakes, and other reptiles, are placed in a vessel and allowed to remain until a mass of rottenness is formed, which is condensed over the fire to a thick paste. The wound made by an arrow thus poisoned generally causes death in from five to ten days, the only possible chance of averting fatal results depending upon the immediate extraction of the arrow head, followed promptly by cauterisation of the wound.

PISCICULTURE IN COLORADO.

According to the report of the State Fish Commissioner in charge of the State breeding pools near Denver, the distribution of the product and the number of fish hatched was as follows:—Brook trout, 300,000; rainbow trout, 20,000; lake trout, 10,000; land-locked salmon, 8,000. The brook trout were distributed as follows;—North park, 20,000; South Arkansas and tributaries, 25,000; Fontaine qui Bouille, 25,000; Platte and tributaries, 30,000; Bear Creek and tributaries, 30,000; Clear Creek, 10,000; South Boulder, 30,000; St. Vrain (Estes-park), 20,000; North Boulder, 25,000; Cache la Poudre, 30,000; Upper Arkansas, 40,000; Ralston, 10,000; retained at hatchery, 5,000. The rainbow trout were distributed in:—Twin lakes, 5,000; Platte Cañon, 5,000; Bear Creek, 5,000; lake trout in Twin lakes, 8,000; land-locked salmon in Twin lakes, 5,000. In addition, 500 German carp were distributed to the owners of lakes in all parts of the State, in lots of from four to twenty. Fish are protected throughout the State by stringent laws. One of the chief objects of the attention that has been given to piscicnlture, is to render the visit to Colorado by tourists as attractive as possible, and as the majority are presumed to be fond of sport, all the streams are kept stocked with such such breeds as are adapted to them, as rapidly as the State Institution can turn them out.

HORSE-BREEDING IN FRANCE.

During the last twenty years the practice of horse-breeding in Normandy has undergone a characteristic transformation. Baron de Vaux, in his work entitled "Les Haras et les Remontes," says that the breeding of the large heavy carriage horse, though having been profitable enough, as well as of the heavy cavalry horse, which, under the Empire, formed the mount of the carabinier, the centgardes, and the cuirassier, has been abandoned. The light, vigorous, wiry, fast, and docile war-horse is disappearing, and the specimens which are still to be found only go to show what horse breeders might have done, and to point out to them the mistakes in the method they are pursuing. Size of the horses is what they are now aiming at, at the expense of all other considerations, and the success of the exportation of such horses to the United States is turning the heads of the horse breeders. North America, Germany, Italy, Spain, and Portugal are large buyers of the draft horse, whose quality for this special purpose is incontestable. The race, by aiming only at size, has undergone a change, and the blood is being infused in an inferior class of horses. The great error committed hitherto in the raising of horses lies in the fact that an improvement is relied upon only by the action of the stallion; small farmers appear to have an idea that any mare is good enough for reproduction, and as a rule they keep only such mares as are not wanted by the trade or the army. Thus it is that at the best breeding districts at the stations where stallions are serving, 60 per cent. of the mares are unfit for proper reproduction. Hence the result that the horse for army purposes is becoming more and more difficult to find, in fact the remounting officer only meets with horses which have been rejected by other buyers. The following particulars throw a light upon the present condition of affairs, and Baron de Vaux states that they are to be entirely relied upon. The officer of the first remounting district (comprising the depôt of Paris, and four others in Normandy) received an order in 1885 for 6,387 horses for cavalry service, to be furnished by the end of July, 1886. Notwithstanding all his efforts, he could not find in this, the richest part of France, more than 3,532, for the reason that they did not exist. Certain details in Normandy show that of 549 horses of the line required, only 247 could be found, and then only by making concessions; neither could light horses be found, as in response to an order for 140, only 97 could be supplied. Again, 10 horses were required for the military riding school, but not one fit for this particular service could be obtained; 1,102 light draft horses for the army were wanted, and only 660 could be found. These figures speak for themselves, the heavy cavalry horse is disappearing, the light cavalry horse does not exist, and the solid, wiry, and tough artillery horse is getting scarcer and scarcer. These remarks regarding Normandy apply with equal force to the whole of France. The following notes are

taken from the last report of the Conseil Général des Haras. The number of mares served by stallions belonging to the Government was 131,351; the number of those served by stallions belonging to other owners, but approved of by the commissioners, 60,306, making a total of 191,658, which, at the rate of 60 per cent. would produce 114,994 fillies. Admitting a death-rate of 50 per cent. for four years, there would remain the number of 57,497 horses produced by superior stallions and by mares of above the average quality. This number is quite insufficient to furnish the 30,000 horses required for the army in ordinary times. In conclusion, Baron de Vaux says:—"This grave state of things is not to be ascribed to a scarcity of horses in France; on the contrary, this country has, relatively, the largest number of horses of any country in Europe; her soil is eminently favourable for breeding them, the most recent statistics give the number of her horses at 3,000,000, but amongst them all, in times of peace, neither the 30,000 wanted for the army, for commerce and private use, nor in war time the 60,000 required to uphold the national honour, and to guard the frontier can be found. The fault lies in the carelessness and want of foresight of the horse breeder, and the insufficiency of the means and resources employed by him."

Correspondence.

DISEASES OF PLANTS.

Mr. EDMUND TONKS writes to Dr. Thudichum:—

I read your first lecture on the "Diseases of Plants," in the *Journal of the Society of Arts*, with very great interest, as it promises to solve a question which has been troubling me for about fifteen years. When comparatively but little versed in the art of horticulture, the plants under my care grew to great perfection; now, with sixty years' practical experience in cultivation, and much study of the laws which regulate growth, in a country ten miles away from a town, my plants, however easy may be their cultivation under ordinary circumstances, are miserable failures, more especially those grown under glass. I have about 200 feet run of glass, divided into eight houses, in which an attempt is made to cultivate many varieties, including tropical fruit and orchids. Your remarks as to mignonette suffering from a rhizoctonia being so entirely in accordance with my own view, that the mischief was caused by some low form of life, either vegetable or animal, induced me to trouble you with my case. It is scarcely necessary to specify the kinds of plants affected, as, more or less, it affects all; but perhaps it is as well to mention a few. Balsams, capsicums, cockscombs, and some others, not only have the rotten roots, but the frizzled leaves; the fig, which used to produce two or three crops of good fruit in the year, barely exists, producing one crop only of fruit no larger than a pigeon's egg; melons will not ripen their fruit; dracænas have repeatedly had every particle of soil washed from their roots, the dead parts cut away, and been re-potted in fresh soil, but before the new roots have filled the pot they begin to decay; primulas, calceolarias, hyacinths, &c , are not now attempted, as they have failed so many years in succession; camellias, roses, pelargoniums, fuschias, solanums, heliotropes, chrysanthemums, ferns, selaginellas, and cactus, are amongst the worst affected, as also are orchids of the easiest growth, such as *Cattleya mossiæ*, *Oncidium flexuosum*, *Dendrobium nobile*, and *cypripedium insigne*. *Dendrobium nobile* now will not grow at all, but there is one peculiarity of the disease, that it scarcely ever kills a plant outright. I introduced to public notice in the *Gardener's Chronicle*, Feb. 28th, 1885, the sulphide of potassium as a remedy for fungoid disease. It is unquestionably fatal to most forms of fungus, but I have been disappointed as to the effects on the disease with which my plants have been affected so long; although the application was made by plunging the plants, soil and all, in a strong solution, and such treatment benefits a healthy plant, it does not arrest the disease of those which are affected. This leads me to think that the cause may be a low form of animal life. There is some reason for believing that this disease, which appears to have been unknown not long ago—and even now is not specifically noticed in horticulturai publications—is extending; the fuschias and other plants at the Chiswick gardens of the Royal Horticultural Society were certainly affected by it two years ago, and other cases have come under my notice. I think it possible that it and not the mite is the cause of the *eucharis* disease, of which so much has been written of late, the mite only feeding on the decayed tissue. The gardener is apt to be hasty in his conclusion, and in the case in question, if he finds rotten roots and a sodden condition of soil, he attributes the former to the latter, whereas the latter may be the consequence of the former.

General Notes.

RUSSIAN BEETROOT CULTIVATION. — From figures given in the *Journal de St. Petersbourg*, it appears that a rather smaller extent of land is under beetroot cultivation in the several provinces of Russia at the present time than last year. The total amount of land in the whole of Russia under this cultivation on the 15th of May last was 243,575 dessiatines, as against 273,081 at the same period in 1886. The dessiatine is equivalent to 2·7 acres.

Journal of the Society of Arts.

No. 1,818. Vol. XXXV.

FRIDAY, SEPTEMBER 23, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

OWEN JONES PRIZES.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their expending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones;" the prizes to "consist of a bound copy of Owen Jones's 'Principles of Design,' a Bronze Medal, and such sums of money as the fund admits of."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1888, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

EXAMINATIONS, 1888.

The Programme for 1888 is now ready.

The subjects in which Examinations are held are as follows:—(1) Arithmetic; (2) English, including composition and correspondence, and *précis* writing; (3) Book-keeping; (4) Commercial Geography and History; (5) Shorthand; (6) French; (7) German; (8) Italian; (9) Spanish; (10) Political Economy; (11) Domestic Economy; (12) Theory of Music; (13) Practical Music.

The Examinations are held at all places in the United Kingdom where suitable Committees can be formed. A fee of 2s. 6d. is required from each candidate in each subject, except Practical Music, for which special fees are charged. 1st, 2nd, and 3rd class certificates are given in each subject.

The Examinations will be held on the 9th, 10th, 11th, and 12th of April.

The Practical Examination in Vocal and Instrumental Music will be held in the Society's house during the week commencing on May 21st.

The Programme can be had gratis on application to the Secretary.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for July 29th.

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.

6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.

7. Hand-tooled Bookbinding, £25, £15, £10.

8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday, 3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered can be obtained on application to the Secretary.

Miscellaneous.

INDIA AT THE COLONIAL EXHIBITION.

An instructive official report on the Indian Section of the Colonial and Indian Exhibition has just been issued by Mr. J. R. Royle, official agent for the Government of India. From the list of officials connected with the Indian Section, both here and in India, and from Mr. Royle's notes on what was done in the different provinces, it is evident that a vast amount of trouble was taken to make the display worthy of our great Asiatic empire by officers whose names the public never heard, but who deserve the highest credit for their zealous and disinterested efforts. The whole of the arrangements were carried out by the new Revenue and Agricultural Department, under Sir Edward Buck, to whom, however, Dr. George Watt, the specialist connected with the department, rendered invaluable assistance. The liberal manner in which the native princes and gentlemen of India responded to the invitation of the executive president of the Royal Commission was, as Mr. Royle justly states, especially remarkable, and it was this which mainly made the Indian Court the most attractive in the Exhibition. Mr. Royle gives the names of about seventy of these contributors. India occupied more than one-fourth of the whole available space for the Exhibition. Mr. Royle describes the classification of the exhibits, and refers to the special arrangement of the Economic Court under Dr. George Watt, who faithfully carried out the desire of the Government of India to take every means of bringing before commercial men the immense value of the products specimens of which were exhibited. For this purpose, among other things, a series of special conferences was organised, to the success of which Mr. Royle testifies, and also to the happy effect of combining the ethnological and agricultural collections with the raw produce, an arrangement which rendered this court one of the most instructive in the Exhibition. The Silk Court, under Mr. Wardle, also receives special mention. The various other features of the Indian Courts are referred to in detail by Mr. Royle, and special mention made of all those who contributed to the success of the undertaking. Among them are the names of Sir E. Buck and Mr. C. S. Bayley, while Mr. Royle states that Dr. Watt rendered very great services, quite independently of his official duties, in lecturing before various public institutions on the resources of India. Mr. Royle rightly bears the highest testimony to the zeal and energy of Sir Philip Cunliffe-Owen, who acted as executive commissioner of India, as well as to the exertions of Mr. Purdon Clarke on behalf of the art collections. The total fund available for providing collections from India was £22,350, besides the value of private contributions and certain provincial grants. It was Mr. Royle's duty to look after the receipts which might accrue from the sale of exhibits. This, it is evident, must have been a work of great magnitude and even worry for Mr. Royle, and the result is highly creditable to his industry and determination. The total sum realised by sales was over £20,000, a result which, taking into consideration the fact that the collections were not chosen for sale, but as being representative of the various manufactures of India, must be considered satisfactory. Mr. Royle enters in somewhat minute detail into the prices realised for various classes of exhibits, and the sums allotted to the various provinces. With regard to the Silk Court, we hope that the very modest claim made by Mr. Wardle will be favourably considered by the Government of India. Besides the articles sold, many specimens from the Economic Court were distributed to Kew and other public institutes. Most of the fire screens in the Art Court have been presented to the Imperial Institute. Altogether, Mr. Royle's report may be regarded as satisfactory.—*The Times.*

SEARCH FOR GEMS AND PRECIOUS STONES.

By P. L. Simmonds, F.L.S.

The insatiate desire for ornaments and articles to decorate the person, and hence the race for the acquisition of wealth, gives employment to thousands of persons in different parts of the world, who are kept busily engaged in searching for gems and precious stones, and in this aspect we would consider it here. It is somewhat difficult to know where the line of demarcation as to "gems and precious stones" is to be drawn, and what properly come within this category, for tastes differ materially, and fashions change from time to time. About one or two, how-

ever, there can be no doubt as to classification; diamonds and pearls have always been highly esteemed and appreciated, and the demand for these is universal. But there are some stones and substances that have value chiefly in special localities, such, for instance, as jade among the Chinese and Pacific Islanders, from its hardness and rarity; amber among the Chinese, Turks, and Russians; and coral among the East Indians, Chinese, and Africans. The African race appreciate the artificial Venetian beads above any valuable gem, because they have long been familiar to them, and are the fashion.

Precious stones have been prized in all ages for their portability, and high intrinsic value in a small compass. In Christopher Marlow's celebrated play, "The Rich Jew of Malta," the merchant is represented as having before him:—

> "Bags of fiery opals, sapphires, amethysts;
> Jacinths, hard topaz, grass green emeralds,
> Beauteous rubies, sparkling diamonds,
> And seld seen costly stones of so great price,
> As one of them, indifferently rated,
> And of a carat of this quality,
> May serve, in peril of calamity,
> To ransom great kings from captivity.
> This is the ware wherein consists my wealth!"

A glance over the various regions of the globe will show us men of all races, in large companies, delving in the ground or diving in the sea for this commercial wealth. Indeed, scarcely a sea or a river but has its fleet of boats at certain seasons laden with men eagerly searching for pearls, although it is chiefly in the tropics that these boats congregate. It may prove interesting to gather a few facts connected with this important quest, taking the searchers on land first, and then investigating the rich produce gathered from the sea.

In the Indian Empire there is a great commerce carried on in gems and precious stones, although no reliable data are available, as they are so portable, and there is no absolute necessity for records being kept. The Indian trade returns of the last three years give the value of the imports at an average of £200,000. A large trade is carried on in them to Sewistan, Kashmir, Ladakh, Thibet, Nepaul, Sikkim, Upper Burma, Siam, and Karennee. There is no doubt that through private sources four or five times the reputed values are brought in and also exported each year to Europe.

There are in India three extensive tracts, widely separated from one another, in which the diamond has been sought for. The name of Golconda, originally applied to a capital town (now a deserted fort in the neighbourhood of Hyderabad), seems to have been used for a whole kingdom; but the town itself is many miles distant from the nearest diamond mines, and it was only the mart where the precious stones were bought and sold. The second great tract occupies an immense area between the Mahanuda and the Godavery rivers; and the third great tract is situated in Bundelcund, near the capital of which—Punnah—some of the mines are found. For those content with a slowly-paying occupation, and a hard life involving close supervision of the workers, diamond mining will pay, provided such persons possess capital sufficient to last them a few years. The diamonds now are usually brought from Parteal, close to the southern portion of the Nizam's dominions. The deepest pits are not more than twelve feet. The matrix of the diamond in those localities is a conglomerate sandstone. The appliances of modern machinery for excavation, &c, directed by men of science, may possibly bring to light gems that have not been discovered by the rude native processes of search.

It would be curious to ascertain the yield of diamonds in the East from those mines in the last 350 years, and of Brazil in the last 150 years since the discovery there, but no such data are obtainable, nor indeed can any reliable estimate be formed of the value of the diamonds owned in different countries. In the United States, diamonds to the value of £1,700,000 were imported in 1886. Two million and a-half carats of diamonds are cut yearly in Amsterdam. Precious stones being free of duty in the chief European countries, no records are obtainable. The Brazilian mines are said to yield about £800,000 of diamonds, and India, Borneo, and Australia £200,000, but these sums are insignificant now in comparison with the South African yield of about £4,000,000 yearly.

The only Indian mines now worked for diamonds are the northern ones in Bundelcund; the produce, between £40,000 to £60,000, is sold locally, and only about 100 carats are sent to Europe. Diamonds have been found in Sumatra and Celebes, but Borneo alone now produces a regular supply, sending it is computed about 3,000 carats annually into the European market. The discovery of Cape diamonds has reduced the Brazilian mining to a minimum of about 24,000 carats. And here it may be desirable to explain what this fanciful diamond weight is. The diamond grain is equal to about four-fifths of a troy grain, hence four diamond grains are equal to one carat, or 3·174 troy grains. But as half the rough stone has to be cut away in polishing, to estimate the value of a rough diamond we must ascertain its weight in carats, double that weight, and multiply the square of this product by £2, which may be taken as the average price of rough diamonds that are worth cutting. Formerly, indeed, the price of diamonds was as to the square of their weight, but this rule no longer holds good, as their value mainly depends upon quality.

From the four principal mines in Griqualand (which all lie within a circle with a diameter of three miles), calculating the amount of diamondiferous ground removed, and the known average yield per load in each, it is found that not less than 33,000,000 carats of diamonds (or more than $6\frac{1}{2}$ tons weight) must have been extracted since the first discovery; realising, in round numbers, £40,000,000 sterling.

The yield of diamonds from the Kimberley mine alone, from the opening in 1871 to the end of 1885, is stated to have exceeded 17,500,000 carats, equal to 3½ tons weight of precious stones, in value about £20,000,000.

To obtain this, as many thousand tons of reef and ground have had to be excavated. The mine is 450 feet deep, and the cubical contents of this huge cavity measures about 9,000,000 cubic yards. Four thousand Kafirs are employed at this mine, and more than 20,000 natives of Africa arrive yearly at the mines in search of work, so that the employment of native labour, and the development of native trade, are incidental benefits conferred on South Africa by the discovery of the diamond fields.

The Dutch Government are the owners of the diamond mines in Borneo, which are situated in the district of Landak, in the territory of Ponteyanak; they are worked by Dyaks and Malays, but with far superior skill by the Chinese. The gems are found in a yellow-coloured gravel, at depths ranging to 60 feet. Advances are made to the miners, who are bound to deliver all stones at 20 per cent. below their market value.

Diamond mining in New South Wales is likely to become of much importance, and the colonists are sanguine of being able to compete with South Africa in this trade. Twelve thousand diamonds have been obtained up to the present time, chiefly from the tertiary gravels and recent drifts in the Bingera, Inverell, and Chittagong districts. The largest diamond yet found weighed 16·2 grains, or about 5⅝ carats. They are of good colour and quality. Companies with large capital are forming to buy up and work the extensive diamond fields in Bingera. Other gem stones found in that colony are garnets, the common emerald (green beryl), oriental emerald (green sapphire), royal blue sapphire, white and pale blue topaz, and agates.

The ruby mines of Burma, when scientifically worked, are destined to yield a vastly increased quantity of this precious stone. There has been lately a sharp competition for the lease of these mines from the British Government, and it is believed that Messrs. Streeter have secured the right for £40,000. It is creditable to England that we have such enterprising firms of jewellers, seeking the produce at the very sources of production, as is evidenced by their explorations in South Africa, their employment of fleets of boats and divers for pearl fishing round the Australian shores, and competition against Indian and Continental firms for the Burma ruby mines. Rubies are of various reds, and the red sapphire or oriental ruby is next in value to the diamond.

It has been well observed that digging for gems, like all gambling speculations, is but too attractive, and great numbers of the rural population in Ceylon and elsewhere neglect the safer pursuits of agriculture for the speculative profits of the gem pits.

Ceylon has always had a reputation for its richness in precious stones. Inferior kinds, such as the moonstone and the garnet, are found in the beds of streams about Kandy, Newara Eleya, Badulla, and some of the small rivers of the south, but the more precious stones, such as the ruby, the blue sapphire, the oriental topaz of various yellows, the Alexandrite and the cat's eye, must be sought within a radius of thirty or forty miles from Ratnapura, the city of gems.

The Ceylon ruby is more frequently of a rich rose colour, having considerably more light and life than its Pegu rival, and is preferred by many Orientals to the pigeon-blood ruby, which, although the more costly stone, is invariably less brilliant than the Ceylon one.

The search for gem stones is carried on in the most primitive manner in Ceylon. The soil supposed to be rich in precious stones is rented for an annual sum from the Government. Coolies are set to work to dig the earth, which is heaped up on one side and then washed through a trough with variously sized perforated zinc stops, which retain all stones, according to their sizes. These are placed on a table or flat surface, and the gems are easily distinguished and picked out. The proportion of gems capable of being cut and really marketable is not more than 1 per cent.

Of the silicious gems, the amethyst of a purplish violet hue is the most valuable. The best amethysts are brought from Cambay in India, and from Siberia, Ceylon, and Persia, where they are found both lining the cavities of geodes and in rolled masses. The chief supply of the blue turquoise is drawn from the peninsula of Sinai, the great mining district of the ancient Egyptians.

Among the Moors, rubies and emeralds, generally uncut, are worn set in finger-rings and huge ear-rings, and necklaces of amber and coral are also prized, The Moors consider that the risk of fraud by imitation is lessened by not having precious stones submitted to the art of the lapidary. This taste for keeping gems in the rough also prevails among many of the Indian princes.

In 1879, thousands of British subjects from Burma passed through Bangkok on their way to the sapphire mines of Siam. The unhealthy condition of the place proved fatal to numbers, and although many realised great profits, the rush soon abated. No royalty was charged on the gems found, but a poll-tax of six shillings was levied at the mines. A sapphire weighing 370 carats in the rough, and 111 when cut, was the largest known to have been found. The ruby, onyx, and jade are also found in this district, but the quality of none of these is such as to make them very valuable.

Year by year great changes occur in the intrinsic value of precious stones from frequent plentiful discoveries. The great find of sapphires in Kashmir and Siam reduced their value some 50 per cent. The discovery of large deposits of amethysts in the interior of Brazil caused 7,000 diamond washers to abandon their usual calling and flock to the neigh-

bourhood of the city of Caeté, but the prices dropped so rapidly that the shipments made did not pay. The diamond market has not been materially affected by any great fall in price from the enormous production in South Africa.

Art has much to do with the manufacture of gem stones. Chalcedony, when stained by metallic oxides, rises to the dignity of a gem stone, as sard, cornelian, chrysophrase, when uniformly tinted brown, yellow, or green; as agate, onyx, sardonyx, when the colours lie in bands or strata. The dull or latent colours are developed by heat or roasting. Black onyx, that is, black stones crossed by bands of pure white, are always artificial.

The precious opal was formerly in high repute, but has gone out of fashion from being considered unlucky—"misfortune's stone;" and yet nothing can be more beautiful than the opals of Hungary and Queensland. The fine collection of the latter was much admired at the recent Colonial Exhibition. The area in which opals are met with in Queensland is large, but only in one or two localities are opals of any value obtained. They are remarkable for their brilliancy and variety of colour, rivalling in that respect those of Hungary. The ultramarine blue colour so finely shown in the Queensland specimens is rare even in Hungary. They are obtained of considerable size, and are of good value. Of other gems, there have been found in Queensland diamonds, rubies, sapphires, topazes, &c., in the tin-bearing drift of Stanthorpe. Agates, which are also employed as burnishers, are met with in large quantities in the Agate Creek, Etheridge goldfield. There they can be procured in all colours and sizes by the hundredweight.

In the opal mines of Dubreck, Hungary, about two miles of galleries are worked under Government supervision, yielding a revenue of £1,200. The opal-bearing rock is not disposed in vein, or bed form, on the contrary the precious stone is found in nests, or pockets, and it not unfrequently happens that a considerable distance may be passed in the workings without showing a sign of an opal.

Like some of their more civilised brethren, the Maories of New Zealand are passionately fond of adorning their persons with trinkets and other ornaments, especially of jade. At the present day many of the decorations formerly used have been discontinued. Ear ornaments are still in general use; they are worn by both sexes, and are of great variety. Those of greenstone, or nephrite, are the most highly prized. The amulet, or neck ornament, is generally of greenstone, carved into the resemblance of a human figure. The image is not unlike a Hindu idol, having an enormous face and badly-shaped legs of disproportionate size. The ear pendants of greenstone vary in form; some are narrow pieces, from 3 to 5 inches in length, and others are round, thin, and flat. The colour of jade varies from almost white to a dark green, but the lighter shades of green are the most highly prized. It is hunted for in the fissures of the precipices and in the streams of Chinese Tartary. Much of it is found in the rivers there by divers. These men work by moonlight, under an escort of soldiers, supervised by Government officers appointed for the purpose, and by whom each piece, as found, is assayed and valued. The imperial jade is of a brilliant green, approaching the emerald in colour.

There are jade quarries in Burma, situated in the Mojaung district, at the head waters of the Churdwen, about 90 miles from Bhamo. They are leased to two companies for £6,000, and the trade is entirely in the hands of the Chinese.

The imports of jade into India are to the value of £30,000 to £40,000. In India jade vases are often ornamented with jewels, or carved and wrought so as to form elegant devices. The old Delhi work in cut and gem-encrusted jade is priceless. The Chinese had cut jade for ages, but never ornamented it, except by sculpture; but when it was introduced into India, the native jewellers, with their quick eye for colour, at once saw what a perfect ground it afforded for mounting precious stones, and they were the first to encrust them on jade. The Indian Museum at South Kensington possesses the choicest and grandest specimens of this work known, of the best Mogol period. (Sir G. Birdwood on "The Industrial Arts of India.")

Blocks of green stone, axes, meres, charms and other articles of jade were shown in the New Zealand Court of the late Colonial Exhibition, evidencing the patient skill of the Maoris in working this hard material, second in this respect to the diamond, although nevertheless somewhat fragile.

Passing now from land to sea, we shall find the busy industry of search as actively carried on. In the coral fishery of the Mediterranean nearly 600 boats are employed, manned by about 6,000 men, the number to a boat varying from 6 to 12 hands. They are sent out from Torra del Greco, Leghorn, Liguria, Sardinia, and the Algerian ports. It is a curious sight to see a fleet of these boats, ranging in size from 3 to 14 tons, employed on the banks with their wooden windlass amidships, hauling up what is termed the "engine," a kind of cross-shaped dredge for tearing off the branches of coral from the rocks. About 400,000 pounds of rough coral are brought in annually to Italy, and the shaping and working of this into the varied forms it assumes for commercial purposes, gives employment to hundreds in the chief cities. The value of the coral shipped from Europe used to reach about £600,000 annually. But with the change of fashion this has declined considerably. Not long ago there was quite a rage for the pale flesh-coloured coral for jewellery. Coral ornaments may again come into fashion, even if they do not fetch the high prices at which they were formerly sold. Coral has the hardness and brilliancy of agate; it polishes like gems and shines like garnet, with the tint of the ruby. In Russia, Northern Africa, and India coral is still much in demand.

The imports into India last year were to the value of £20,000.

Amber was one of the most valuable jewels of antiquity. It was endowed with manifold sympathetic effects as a talisman against rheumatism, toothache, and other complaints. The Turks still believe it to be an infallible guard against the injurious effects of nicotine, hence its extensive use for the mouthpieces of pipes. Amber is esteemed for ornaments by many. The cloudy, or milk-white, and the opaque lemon-coloured, are the varieties most valued by connoisseurs. The imports to this country are to the value of about £3,000 to £4,000, but it is largely shipped also to Austria, France, Turkey, and the Eastern nations. It is principally obtained on the Prussian coast of the Baltic, from Dantzic to Memel. At one establishment near Memel dredging is carried on day and night by "shifts" of men, 400 being so engaged. At another, in Konisgsberg, 2,350 persons and nineteen steam-engines are employed. The pits are 300 feet deep, and 100 carts are employed on the works. In other localities divers are employed, two to each boat, with submarine clothing and air-pumps.

The fishing for pearls and mother-of-pearl shells is carried on in very many quarters: in Lower California, the coasts of Mexico, the Bay of Panama; in the Red Sea, the Persian Gulf, Ceylon, Borneo, New Guinea, the Sooloo Isles, Fiji, the Society and other of the Pacific Islands, and on the east and west coasts of Australia. The pearl fisheries on the coasts of Central America furnish about £100,000 worth of pearls, and employ about 1,000 divers. Our imports of pearls average in value about £100,000; France receives about the same. The marketable value of pearls is much higher in Asiatic countries than elsewhere, hence the best are sent to Bombay, where fancy prices are often given for good pearls.

At the Bahrein fishery in the Persian Gulf, many hundred boats are employed, manned by from eight to twenty men, and the value of the pearls obtained is stated to average £1,000 yearly, but this amount of course varies. The larger and more valuable pearls are believed to be sold secretly. The men receive two-thirds of the catch, after deducting expenses, and for food, &c.

The great pearl fishery of Ceylon is carried on at stated periods on the banks of the north-west coast of the island, at the entrance to the Gulf of Manaar. As it is a Government monopoly, great care is now taken to give rest to the fishery, so as to allow the oysters to attain a maturity of five or six years, which will warrant a rich yield of pearls. There is a prospect of a good pearl fishery in 1888, and it is confidently expected that as many as 300,000,000 oysters will be fished, requiring every boat and every diver procurable in Ceylon and Southern India. The small, thin shells of this oyster (*Avicula fucata*), unlike the heavy, true mother-of-pearl oyster (*Meleagrina margaritifera*), have little or no commercial value, and are chiefly burnt for lime.

When a fishery is proclaimed, the arid sands at Arippu, on the north-west coast, becomes as it were, a bustling town of tents, filled with people of varied races and occupations, including boatmen from the Coromandel coast, pearl dealers from India, Malaya, and China, with the accompaniments of merchants and traders of all classes. The Ceylon Government takes as royalty two-thirds of the oysters gathered, which are sold by auction at the close of each day's fishing. Only a limited number of boats and divers are licensed to fish.

The fishing can be carried on only during the very calmest period of the north-east monsoon—February to April. In these months the wind blows off the land during the night, and off the sea during the day, which enables the large fleet of fishing boats to reach the pearl banks by daylight on each morning, returning with their cargoes shortly after noon. The boats, containing twenty men (half divers), are divided into two fleets, which go out to their work on alternate days. The price realised for the oysters varies from £2 to £7 the thousand, the value depending to a great extent on that of a sample of 5,000 lifted in the early part of the fishing. The contents of the mollusc being allowed to decay before the pearls can be obtained, the stench is horrible. The congregations of pearl dealers, petty traders, official subordinates, and labourers on the shores, is enormous.

About the island of Borneo there is a good deal of fishing for pearls, which are found in a thin, flat, pinkish-shelled oyster, known locally as *salesiep*. This lives only in shallow brackish water at the mouth of rivers. Several boats rendezvous at the same time and place to frighten the crocodiles and sharks. Twenty or thirty persons will be in the water at once, diving, splashing, laughing, and shouting, and bringing up three or four shells at a time; extra yells from all hands salute a rather larger find than usual. Very few of the pearls obtained are of any value individually; they are chiefly seed-pearls, which are sent to China, where they are pounded up, made into powder, and this is swallowed by ladies who desire to improve their complexion; at least, such is the story. From British North Borneo the value of the pearls exported in a year is £500. Pearls of a very high price are not infrequently to be bought at Sandakar, but they come principally from the islands of the Sooloo Archipelago. The largest ever seen there was valued at £1,600.

The formation of pearls is not limited to the bivalves, they are produced on several univalves, especially on the *Strombs* and *Turbinellas*, but are more rare in these than in the bivalves. About the Bahamas group of islands and cays, the shells of the king, queen, and common conch were much sought after for sale to the cameo-cutter, but the fashion for cameo jewellery has passed away. The common conch is the ordinary pink-mouthed shell so frequently seen in milk shops. It furnishes the rare pink pearls, so much appreciated, and these are exported from the Bahamas to the value of about £3,000 annually.

Some fine collections of these pink pearls, set and unset, were shown at the Fisheries and Colonial Exhibitions in London.

It was once thought that no other pearls than those produced by the pearl oysters could obtain a rank among gems; but some of the river pearls found in species of mussels (*Unios*) compete closely with those from the mollusca of the ocean. These river pearls are found widely diffused in France, Saxony, Bavaria, Bohemia, and Silesia, as well as in the lochs and rivers of Scotland, Ireland, and Wales. In China, the rivers of Manchouria furnish a good many. Delegates from the royal household look out for the best of these pearls there for the ladies of the Imperial Court.

In many of the Scotch rivers old men, women, and children may be seen wading about the shallow fords, and when they discover a collection of mussels, they thrust down long sticks split at the ends, and bring up the mussels wedged in the slots. In the shallow waters of the Dee, the boatmen look down into the water with a tin having a glass bottom, and when shells are discovered, they are brought up by a kind of dredge, or scoop, and frequently some fine pearls are obtained.

These pearl mussels are also found in most of the small streams of the province of Quebec, and in the districts bordering on the lower St. Lawrence. The streams most abounding in pearl mussels are but little known, except to Indians and backwoodsmen, who are careful in guarding the secret of where these molluscs are found.

Occasionally a party of pearl seekers may be seen paddling in a bark canoe, and portaging through a very wild region. After opening several thousand mussels, they will only succed in securing a few good pearls. These vary in colour from white to dark brown; the white are appreciated for their rarity, and the pink on account of their peculiar brilliancy. In form they are generally round or spherical, and have a hard skin with an iridiscent or nacreous hue.

It would lead to too much detail to pass under review the various pearl fisheries of the Australian Coasts, the Eastern Archipelago, and the Pacific Islands, where the unclothed native divers have to brave the attacks of sharks, cephalopods, and other dangers. They especially dread the stings of the jelly fish, which they say are speedy death to them. Enough has, however, been stated to show the importance of this wide-spreading industry of hunting for gems and precious stones. Fine collections of these are frequently brought before the public to feast their eyes on, as at the recent Colonial and Indian Exhibitions in London, and those at Amsterdam, Paris, and elsewhere.

At the Fisheries Exhibition in London, a firm of Parisian jewellers showed among others a very choice five-row necklace of 355 selected oriental pearls, weighing 2,570 grains; a matchless and unique necklace and parure of Scotch pearls; a very important black pearl necklace, composed of 39 pearls, weighing 1,020 grains; a round pearl of 96 grains, being one of the finest pearls known, and worth £20 a grain; a very important collection of Oriental pearls, composed of 3,345 grains original, such as are most prized in Bombay, besides black, pink, yellow, and grey fancy pearls.

For further information on these topics, I may refer to my paper on "The Pearl, Coral, and Amber Fisheries," *Journal*, vol. xviii, p. 173; and to my work on "The Commercial Products of the Sea."

THE HERKOMER SCHOOL.

The first meeting of the Herkomer School, under the new constitution, has been lately held. The President (Professor Herkomer, M.A., A.R.A.) having taken the chair, the Treasurer (Mr. T. Eccleston Gibb) said:—This school has now been carried on for four years, and it has achieved a success which does not usually follow new institutions. During that time I have taken the chief responsibility connected with finance, and Professor Herkomer has entirely controlled the teaching. We commenced without any written agreement, simply trusting each other as friends. We promised each to do his part, and we have never had a dispute or misunderstanding. It is not for our sakes, but for the sake of the future of the school, that the constitution of our school is to be changed, and it is for you—the fellows, associates, and students of the Herkomer School—to make, or assist us in making, the influence and benefits of the institution still further felt. We have adopted a new constitution, and are now to be governed by formal bye-laws, rules, and regulations made by a Council and by an Academic Board, instead of being governed as heretofore by the mutual wishes of two individuals. We have taken new responsibilities. We are an art colony modelled on a perfectly unique plan, combining many of the advantages of the teaching systems of the ancient masters with what is best in the systems of modern art schools, and we are presided over by one who as a teacher and as a man stands unsurpassed. The Herkomer School comes at an important time, and assumes an important place. Its doors are open only to those who are sincere and thoroughly in earnest in their desire for study. It is not a place for beginners, yet in this respect we have modified our original plan by establishing the preliminary class. . . . .

Professor Herkomer then delivered an address, from which some extracts are here made:—

My dear students,—I will now give you my sketch of the school. This school, which bears my name, is unique in the history of art schools—unique in its origin, in its locality, in its method of tuition, and (for the short time of its existence) unique in its results. The whole secret of this is bound up in the fact —the singular fact—of my having a neighbour in Mr. Gibb, who was generous enough to give a large sum

of money for the building of this school, which was to have no other authority or influence than my own. This absolute power alone has enabled me, through difficulties and complications, to stop all dangerous influences, and to give to the school the life and vitality that will now, in its new form, continue to stamp it through its whole (I hope long) future. . . . . We aim at retaining the English feeling for Nature, with the addition of some better technique than is encouraged in most English art schools. We further aim at the individual development of each artistic nature, and I have already had my strong belief in the possibility of this method strengthened by the results. Not one of our successful students has a touch of my own manner in painting. This is one of the school's triumphs; no samples to guide or misguide you, and no prize work, has brought this about. Working for prizes would soon lead to a school manner, and then to a mannerism that would become a barrier to all individuality of style. All students in our school can develop the style of work that is to be peculiarly their own. The master can only coax out the ability that is in you. But how much better to help you to become yourself, than to train you to carry a borrowed shell. This borrowed shell is a false weight; it will ultimately crush you if you are not strong enough to throw it off. It is misleading to you, and to others who watch your progress. In this school you can gauge your strength or your weakness. If you succeed, the success is your own, and means strength to be relied on. If you fail—well, you will know what it means. You will not waste a life in a useless pursuit after a selfish craving, for such it becomes if time and practice have shown that there is not enough natural ability in you to justify prolonged study. You will not add another to the ghastly list of mediocre painters. There is other work to do in the world besides painting pictures. But you will be the better men and women for having had a trial with fair and honest means. Therefore, whatever you learn here belongs to you, and becomes part of your own composition. I soon felt how unsatisfactory it was to take only advanced students. It meant getting rid of borrowed shells—shells that I found stick uncommonly fast; or I had to bring to life benumbed identities. But it was often too late, and it was only like galvanising a lifeless spark. Therefore the establishment of a preliminary class, under my pupil Wehrschmidt, brought new life to the school. It supplies the life class with students of the right calibre, who have no bad habits to unlearn. I cannot invent a fairer plan of admitting students from this class into the life class than by letting them draw from the nude, and passing them into the life class by their drawings, without knowing who did the drawings. No doubt many are nervous whilst drawing, and are materially hindered from doing their best under the excitement; but I am perfectly convinced that the artistic tendency and general tenor of the student's mind will be visible in the most nervous drawing. . . . . I have mentioned that students who have left us are coming back. The five studios I have lately built for five of the successful students, form the nucleus of the art colony that is growing rapidly in Bushey. And I know no existence more ideal for the young painter than to be in the country, with all its artistic charms to inspire him—with pure air and pure light, combined with an artistic atmosphere—with no cliquish tendency to narrow the society, and yet to be within easy reach of the great centre, London.

RIBBON INDUSTRY OF ST. ETIENNE.

The United States Commercial Agent at St. Etienne says that the ribbon industry, which was introduced into St. Etienne in the 10th century, was for a long time inferior to that of St. Chamond, where at present, however, only special articles, such as braids, for example, are made. It is at St. Etienne exclusively that has existed for forty years the public test for silk destined to be manufactured into ribbons. The manufacture of velvets and ribbons absorbs annually from 5,000 to 6,000 kilogrammes of silk, representing a value of from 30,000,000 to 35,000,000 francs. The value of ribbons manufactured is from 70,000,000 to 80,000,000 francs. The *rubannerie*, or ribbon industry of St. Etienne, is carried on by about 250 manufacturers, who are engaged in making many different articles, such as plain, black, coloured, and figured ribbons, velvets, elastic goods, trimmings, braids, cravats, cords, galoons, &c. These manufacturers employ 18,000 looms, and 50,000 workmen. The greater part of the looms of St. Etienne are worked by hand, and belong to the workmen themselves, who own small factories of from two to four looms. These looms are generally very well arranged, and perform the work well, and the manufacturers of St. Etienne, in view of the constant changes of fashion, find a great advantage in this arrangement. A manufacturer who creates a new article finds looms to produce it at a smaller cost than if he had extensive works, and were obliged to exchange all his machinery. Looms for velvet generally belong to the manufacturer, as well as those for the fabrication of elastic ribbons, braids, &c. It is estimated that the number of looms worked by steam or water power amounts to 2,000 or 3,000. There is no fixed rate of pay for workmen, as it varies according to the demand. Each ribbon requires a special agreement between employer and *employé*. While one man with a loom able to produce the article in vogue will gain from 10 to 20 francs a day, another with a loom producing a less fashionable fabric will make but 2 to 3 francs. Until the year 1872, Mr. Coleman says that work was regular enough at St. Etienne; economical workmen grew rich, and most of the houses in the city were built by them; but since then the condition

of the workmen has been less favourable, wages have been lower, and many have been out of employment. The ribbon production of St. Etienne formerly amounted to 110,000,000 francs yearly; this included braids also, which are now principally manufactured at St. Chamond. At the present day, the combined production of St. Etienne and St. Chamond is estimated at a sum not exceeding 90,000,000 francs. Until the year 1872, two-thirds of the ribbons manufactured were for exportation; at the present day those destined for exportation do not exceed one-third.

Notes on Books.

THE METALLURGY OF SILVER, GOLD, AND MERCURY IN THE UNITED STATES. By Thomas Egleston, LL.D. Vol. I.—Silver. London: Offices of *Engineering*. 1884.

The author states that, previous to the discovery of gold in California in 1848, the United States produced only a small portion of the world's product of metals, and that its people were not skilled in the mining or metallurgical sciences. The discovery of copper on the upper peninsula of Lake Superior, and of gold in California, drew attention to this want of knowledge, and gave the stimulus that was required. Dr. Egleston adds:—"Twenty-five years ago there was no place in the United States where an elementary knowledge of either mining or metallurgy could be had in any of the educational institutions of the country. To-day a more thorough knowledge of these sciences can be had here than anywhere else." The author then proceeds to show what has been done, and to describe the machinery in use, which description is fully illustrated by diagrams. In his introduction Dr. Egleston treats of gold, and gives a generalisation of his subject. The first chapter is devoted to silver ores and smelting, the second to zinc desilverization, the third to the separation of gold and silver from copper, the fourth to crushing machinery, the fifth to roasting silver ores, the sixth to the Patio and Cazo process, the seventh to barrel amalgamation, the eighth to pan amalgamation, the ninth to the treatment of silver tailings, and the tenth and last to leaching processes.

DURRANT'S HANDBOOK FOR ESSEX. With an Introduction treating of its history, geology, area, population, literature, antiquities, worthies, natural history, &c., by Miller Christy. Chelmsford: E. Durrant and Co. 1887.

This handbook contains a full account of the different places in the county, which are arranged in alphabetical order. It is illustrated with a map and two plans, one of Colchester, and the other of Epping Forest.

THE STATISTICAL ATLAS OF COMMERCIAL GEOGRAPHY. By E. J. Hastings. Edinburgh: W. and A. K. Johnston.

A series of diagrams showing the extent of imports of the different countries of the world in 1886, and exports in 1885, with diagrams of the produce of different countries in 1885. Each square represents a certain value or quantity, the amount being stated on each sheet; and the statistics on which the diagrams are based are taken from Parliamentary and official returns.

General Notes.

THE IRON INDUSTRY IN COLORADO.—The Colorado Coal and Iron Company give the following figures as the result of their operations for the year 1886. The output of pig iron, however, is the result of only five months' running, and the steel rails that of only four months' operations. Coal, 615,360 tons; coke, 112,200 tons; pig iron (five months' running), 9,323 tous; spiegeleisen, 982 tons; steel rails (four months' run only), 5,872 tons; merchant bar iron, 4,240 tons; castings (for their own use only), 621 tons; cast-iron pipes, 995 tons; nails (kegs of 100 lbs. each), 53,250 tons; railway spikes (kegs of 150 lbs. each), 3,370 tons.

FACTORY LEGISLATION IN HOLLAND. — The Commission entrusted with the investigation of the question of women's and children's work in Dutch factories, has recommended that young people under the age of 16 shall not be employed. It is also proposed to introduce partial restrictions as to the employment of those under 18, together with a provision for two hours rest in the day. The Commission moreover advocates the enactment of laws for ensuring the safety and health of the employed, the appointment of factory inspectors, and the adoption of measures for the assistance of work-people and their families in cases of death, illness, old age, or accident.

PARKES MUSEUM.—The fourth course of lectures and demonstrations for the instruction of sanitary inspectors will be given on the following Tuesdays and Fridays, at 8 p.m.:—September 27th, Introductory Lecture, "General History, Principles, and Methods of Hygiene," Dr. H. E. Armstrong. September 30th, "Ventilation, Measurement of Cubic Space," &c. October 4th, "Water Supply, Drinking Water, Pollution of Water," Dr. Louis Parkes. October 7th, "Drainage Construction," Prof. H. Robinson. October 11th, "Scavenging, Disposal of Refuse and Sewage," Mr. J. Gordon. October 14th, "Sanitary Appliances," Prof. W. H. Corfield, M.A., M.D. October 18th, "Food (including Milk), Sale of Food and Drugs Act," Mr.

C. E. Cassal. October 21st, "Infectious Diseases and Methods of Disinfection." October 25th, "General Powers and Duties of Inspectors of Nuisances, Method of Inspection," Mr. J. F. J. Sykes, B.Sc. October 28th, "Nature of Nuisances, including Nuisances the abatement of which is difficult," Mr. J. F. J. Sykes, B.Sc. November 1st, "Sanitary Law—General Enactments, Public Health Act, 1875, Model Bye-Laws," Dr. Charles Kelly. November 4th, "Metropolitan Acts, Bye-Laws of Metropolitan Board of Works," Mr. A. Wynter Blyth.

THE LIBRARY.

The following books have been added to the Library since the last announcement :—

Artist (The): Edited by Prince Hoare. 2 vols. (London: John Murray, 1810.) Presented by Mlle. Hellouin.

Balfour, Surg.-Gen. Edward.—The Agricultural Pests of India. (London: B. Quaritch, 1887.)

Beale, E. J.—English Tobacco Culture. (London: Marlborough and Co., 1887.) Presented by the Author.

Begg, Alexander.—The Great Canadian North-West: its Past History, Present Condition, and Glorious Prospects. (Montreal: 1881.) Presented by the Author.

Beken, George. — Freehold Disfranchisement. (London: Liberty and Property Defence League.) Presented by the Author.

Canada under the National Policy. Arts and Manufactures, 1883. (Montreal: the Industrial Publishing Co., 1883.) Presented by Alexander Begg.

Christy, Miller.—Durrant's Handbook for Essex. (Chelmsford: Edward Durrant and Co., 1887.) Presented by the Publishers.

City Liberal Club, Catalogue of the Library of. (London: 1887.) Presented by Hyde Clarke.

Davenport, F.—Elements of Harmony and Counterpoint. (London: Longmans, Green and Co., 1887.) Presented by the Publishers.

Ferguson, A. M. and J.—Ceylon Directory and Handbook for 1885-6. (Colombo.) Presented by John Haddon.

Fleming, Sandford, C.M.G.—England and Canada: A Summer Tour between Old and New Westminster. (London: Sampson, Low and Co., 1884.) Presented by Alexander Begg.

Flower, Major Lamorock.—The River Lee: a paper read at the Parkes Museum. (London, 1887.) Presented by the Author.

Hargrave, J. J.—Red River. (Montreal, 1871.) Presented by Alexander Begg.

Hastings, E. J.—The Statistical Atlas of Commercial Geography. (Edinburgh: W. and A. K. Johnston.) Presented by the Publishers.

"Hercules."—British Railways and Canals in relation to British Lands and Government Control. (London: Field and Tuer.)

International Conference on Education, 1884. Proceedings: 4 vols. (London: William Clowes and Sons, Limited, 1884.) Presented by the Publishers.

Lawrence, Edwin.—The Progress of a Century. (London: H. Vickers, 1886.) Presented by the Author.

Lorne, Marquis of.—Our Railway to the Pacific. (London: Isbister and Co., Limited, 1886.) Presented by Alexander Begg.

Lloyd, Frederick James.—The Science of Agriculture. (London: Longmans, Green and Co., 1884.) Presented by the Author.

Newcastle-on-Tyne Public Libraries.—Catalogue of the Central Lending Department. (Newcastle-on-Tyne, 1880.) Supplementary Catalogue of Books added to the Lending Department. (London, 1887.) Presented by the Chief Librarian.

Nicoll, Donald.—Telegraph and Telephone considered in relation to Economy and Efficiency. (London: Robert Booth.) Underground *versus* Overhead Wires. (London: Robert Booth.) Presented by the Author.

Richardson, B. W., M.D., F.R.S.—The Health of Nations; a review of the works of Edwin Chadwick. (London: Longmans, Green and Co., 1887.) Presented by the Publishers.

Robins, Edward C., F.S.A.—Technical School and College Building. (London: Whittaker and Co., 1887.) Presented by the Author.

Rondot, Natalis.—Essai sur les Propriétés Physiques de la Soie. (Paris, 1887.) Presented by Thomas Wardle.

Sedie, E. delle.—Esthetics of the Art of Singing and of the Melodrama. 4 vols. (Milan: Ricordi, 1885.) Presented by the Author.

Smith, J. Bucknall, C.E.—A Treatise upon Cable or Rope Traction, as applied to the working of Street and other Railways. (London: *Engineering*, 1887.) Presented by the Editor of *Engineering.*

Smith, Dr. R. Angus, LL.D., F.R.S.—Life and Works of Thomas Graham, D.C.L., F.R.S., illustrated by sixty-four unpublished letters, edited by J. J. Coleman, F.C.S. (Glasgow: John Smith and Sons, 1884.) Presented by the Editor.

Stretton, Clement E.—Safe Railway Working. (London: Crosby Lockwood and Co., 1887.) Presented by the Author.

Technical Instruction: Second Report of the Royal Commissioners. 4 vols. (London, 1884.) Presented by G. A. Thrupp.

Unwin, William C., F.R.S.—Exercises in Wood-working for Handicraft Classes in Elementary and Technical Schools. (London: Longmans, Green, and Co., 1887.) Presented by the Publishers.

Wardle, Thomas.—Les Soies des vers sauvages de l'Inde, et leur emploi dans l'industrie. (Paris, 1887.) Presented by the Author.

Journal of the Society of Arts.

No. 1,819. Vol. XXXV.

FRIDAY, SEPTEMBER 30, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.
7. Hand-tooled Bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday, 3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered was given in the number of the *Journal* for September 16th last, and can be obtained on application to the Secretary.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for July 29th.

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF SUBSTANCES TAKING PART IN PUTREFACTION AND ANTISEPSIS.

By John M. Thomson, F.R.S.E., Sec.C.S.,
Demonstrator of Chemistry, King's College, London.

Lecture I.—Delivered May 2nd, 1887.

As the employment of agents, chemical and otherwise, for the preservation of natural products, and for the prevention in them of decay, as well as the use of chemical substances as counteracting agents to the spread of disease, have become so general among the public in the last few years, I thought that the present course which the Council of the Society have done me the honour to ask me to give might be usefully occupied with a description of the more important properties of some of these substances, and with the general bearings of some of the changes which lead to their production.

I am well aware that in doing this I shall not be able to bring before those who may already be practically engaged in such questions anything that is particularly new, but my wish and endeavour will be to put before you the material suggested by the syllabus in a manner suitable to a general audience, such as the members of the Society represent.

As the consideration of fermentation in its relation to industrial processes has been so often and ably given in this room, it is not my intention in this course to deal with its special changes. My object rather is to deal with the formation and properties of those substances which are produced in the changes which are grouped together under the name of putrefaction, and which it is our special object to

check or prevent by the use of agents, which are termed disinfectants.

Before passing, however, to such a special consideration, it is necessary that we glance at certain general questions as to the supposed origin of these changes, and the reactions taking place when such changes occur, so that we may the better understand the properties of the bodies produced in them.

It is my intention then to divide the consideration of the matter indicated by the title as follows :—

First, to consider the general questions affecting the changes taking place during certain processes of fermentation and putrefaction.

Secondly, to pass to the special properties of the more important chemical substances produced in such changes, dividing them as far as possible into groups.

In the third place, to deal with general questions relating to the retardation or prevention of putrefaction, more especially with chemical methods adopted for such prevention.

And finally, to consider the chemical properties of the more common and important substances employed as antiseptics.

In the popular sense, the processes of fermentation and putrefaction are regarded as distinct, and the term fermentation is applied only to such changes as are carried out with the production of no offensive odour; putrefaction, to those still further changes which occur, more marked perhaps in animal than in vegetable substances, and which are accompanied by distinct putrid odours. Thus the change which produces alcohol from sugar is regarded as fermentation, while the production of sulphur compounds, &c., in the decaying egg or some other animal body is marked as putrefaction.

The chemical operation of both, however, is of the same kind, consisting in the resolution of complex substances into simpler forms; the complex organic substances becoming broken up into simpler ones, these in their turn becoming converted into still simpler forms, and finally into so-called inorganic substances, as carbon dioxide, ammonia, hydric phosphide, water, hydric sulphide, and sometimes even into the elementary gases, hydrogen and nitrogen.

Under ordinary circumstances these changes are generalised, as fermentation and putrefaction which take place at the same time as the development of living plants or organisms; and the presence of some or all of these is one of the conditions necessary for the production of such changes.

We shall see, however, later on, that certain unorganised substances may be obtained which are capable of exciting and carrying on many of these changes; but as none of these substances have as yet been synthesised from simple materials, and all are dependent for their formation, so far as we at present know, upon what are called "life processes," the first remark is true for all fermentation and putrefaction taking place around us in nature, and not produced by any direct or special experiment of our own.

The change taking place during ordinary fermentation is best seen by the formation of carbonic acid gas or carbon dioxide, which is evolved during the conversion of sugar into alcohol by the action of the yeast ferment. It may be shown experimentally by placing the yeast and sugar in a glass globe which has a delivery tube attached to it, by means of which the CO_2 evolved may be collected in a cylinder over water. This change, as we shall see later on, takes place more quickly on the application of a gentle heat, but this must not be to such an extent as to destroy the yeast cell.

Although the sugars present the best known instances of bodies liable to ferment, the starches, dextrin, &c., may also be made to undergo a similar change; it will be seen, however, that this change entails the conversion of the starch first into one of the varieties of sugar, viz., glucose.

$$\underset{\text{Dextrin.}}{C_6 H_{10} O_5} + H_2O = \underset{\text{Glucose.}}{C_6 H_{12} O_6}.$$

$$C_6 H_{12} O_6 = \underset{\text{Alcohol.}}{2(C_2 H_6 O)} + 2\,CO_2$$

The chemical properties of starch and sugar are very different, although the one may be converted into the other. This is readily seen by adding a solution of iodine to a large volume of starch solution, when we at once get a brilliant blue colour; extremely minute quantities of starch sufficing to show the reaction.

Sugar, on the other hand, shows no such tendency, but on its part may be recognised by its reducing power on certain salts of copper, one of which the tartrate (Fehling's solution) may be used. This test can also be employed to indicate the difference between the two varieties of sugar which are commonly dealt with, viz., the glucose or grape sugar and the cane sugar. On adding the copper

solution to the solution of glucose, and warming, we have an immediate deposition of copper suboxide. With the cane sugar, however, it requires boiling for some considerable time before the precipitate is obtained; the reason of this being, as many of you know, that the cane must be converted into grape sugar before the reaction takes place.

The assimilation of water by starch, with its conversion into glucose, can be readily effected by boiling for a short time with water and an acid, when the nature of the starch is entirely lost, and the presence of sugar made apparent. You see this now going on before you, and, on dividing and cooling the solution, one portion shows us nothing by our iodine reaction; whilst the other portion shows abundant evidence of sugar by the copper reaction.

Whatever may be the particular change which ultimately takes place during the process of different fermentations, it is now established that such changes will not take place under ordinary circumstances, unless originated by the entrance into the fermenting solution of some medium carrying the particular germ which starts each particular change.

From the earliest times, it was supposed that the lower forms of life were evolved from dead matter, and that substances like flesh and cheese were converted by putrefaction into living animalcula. This view was first proved to be erroneous by the experiments of Redi, in 1638, who showed that when the material liable to decay was covered with gauze, the cause of the putrefying changes was entirely removed. Further light was thrown on the determining cause of those changes by the experiments of Schroeder and Dusch; who demonstrated the fact that air when filtered through cotton wool, before coming in contact with the organic matter, had entirely lost its active power. Later, the experiments of Schwann showed that other preventive causes might be employed, such as the heating of the air, or its passage through certain corrosive chemicals, as potash or sulphuric acid.

Viewing the existing cause of these changes in the most general manner, it is now quite established from the work of Pasteur, Tyndall, and many others, that each form of fermentation or putrefaction has its own specific germ or primal cause, and that if this be prevented from coming in contact with the putrescible liquid, no change will take place.

It is somewhat difficult to exhibit quickly to an audience any change arising from the introduction of such a germ, but this may, to a certain extent, be done by taking advantage of other phenomena with which we are acquainted, and which show us most distinctly the presence of such active bodies in the air.

If we prepare a solution of sodium sulphate in a state of so-called supersaturation, and allow it to cool, covered with cotton wool, the salt will remain in solution, although disturbed by many causes, until there enters the flask a particle of the substance itself, when crystallisation, as you see, at once begins, and finally passes through the whole of the fluid.

Should, however, the air be filtered through cotton wool, breathed through the lungs, or passed through a red-hot tube before entering the solution, the active nature of the nucleus, or germ, is at once destroyed. This may be seen in the arrangement before you, where we pass a current of heated air through the flask containing the supersaturated solution without any action taking place; on removing the heated tube, however, and replacing it by a cold one, and again drawing air through the flask, after a short delay crystallisation is produced.

The question of the special nature and action of the living organism capable of starting such changes is one which belongs to the province of the biologist, and must be treated of specially by him; it is a department of the subject quite outside the scope of our present considerations.

The changes which we regard as producing fermentation and ultimately putrefaction may be divided into two large classes:—

(a.) Those which are inseparable from the living action of some organism; as the conversion of glucose by the action of yeast into alcohol and carbon dioxide.

(b.) Those which may be brought about by means of an unorganised substance free from germs, as in the cases of diastase, ptyalin, tripsin, steapsin, &c.

Whether the fermentable change may belong to one group or the other, it is always necessary that an exciting cause be present, whether it be the nitrogenous substance in an active state of change as yeast; or the substance as ptyaline, which itself apparently unaltered, produces a change in the substance to which it is introduced; in either case contact with the fermentable or putrescible liquid is apparently necessary.

This actual contact of the agent with the substance acted upon has been strongly insisted upon by Mitscherlich, who carried out

an experiment showing that if the yeast ferment be separated from a portion of the sugar solution, the production of alcohol will only take place in that portion in which the ferment comes in contact with the sugar solution. For this purpose a glass tube, the bottom of which was covered with a piece of fine filter paper, was partially immersed in a solution of sugar. The solution rapidly passes through the paper and fills the tube to the level of the liquid in the outer vessel. A small quantity of yeast was then added to the solution in the inner tube; this, after a short time, commenced fermenting, with the production of carbon dioxide. There was no sign, however, of fermentation in the outer vessel, the bibulous paper preventing the passage of the yeast cells. It is well to note, however, that there is a certain amount of evidence of changes producing substances other than alcohol in the outer vessel containing the sugar.

With regard to this question of actual contact, it seems most probable at the present time that, where the action can not be separated from the life processes of the living organism, such contact as we have seen in the flask is absolutely necessary. In these classes of fermentation, however, in which an unorganised substance is capable of producing the change, the presence of paper, or material through which an interchange of fluids may take place, may not interfere with the action, although it may cause delay.

Let us now consider more closely the second kind of fermentation which I have mentioned, namely, the "changes produced by substances other than living organisms."

This may be seen in the formation of what is known as "oil of bitter almonds," which is obtained by mixing an emulsion of sweet almonds with one of bitter almonds. The first of these contains a substance known as emulsine, whilst the second a complicated substance termed amygdaline. When the emulsine is dissolved in cold water, and mixed with a solution of amygdaline, the latter undergoes change, the oil of bitter almonds being formed in abundance; if the solution of emulsine be boiled, however, it is incapable of forming the essence. The action probably taking place in this case of fermentation may be represented as—

$$\underset{\text{Amygdaline.}}{2\,(C_{20}\,H_{27}\,NO_{11})} = \underset{\text{Bitter Almond Oil.}}{4\,(C_7\,H_6\,O)} + 2\,HCN + C_6\,H_{14}\,O_7 + 4\,CH_2\,O_2 + 3\,H_2\,O\,;$$

or according to some—

$$C_{20}\,H_{27}\,NO_{11} + 2\,H_2\,O = 2\,C_6\,H_{12}\,O_6 + \underset{\text{Bitter Almond Oil.}}{C_7\,H_6\,O.\ \ HCN.}$$

The change occurring here is best seen experimentally by testing the original substances with potash and ferrous sulphate, when no change in colour takes place; on applying the same test to the fermented liquor we have at once the presence of a cyanide evinced to us by the deep blue colour produced.

More interest perhaps attaches to the change of urea into ammonium carbonate by a putrefactive action, which was at one time believed to be excited by the mucus, a decomposable substance resembling albumen, and existing in the urine. The conversion may be thus expressed—

$$\underset{\text{Urea.}}{CH_4\,N_2\,O} + 2\,H_2\,O = (NH_4)_2\,CO_3.$$

For a long time this change at the ordinary temperature was considered to be inseparable from the action of living organisms, but the recent experiments of Mr. Sheridan Lea have shown that it is possible to extract from a solution of urea in an active state of change an unorganised substance free from living organisms, but which will excite the change in a fresh solution of urea, and which can be kept, with care, in a dry state for a considerable length of time.

Another instance of the same kind familiar to you all, is the change produced in the curdling of milk by the formation of casein by means of rennet. Originally this was supposed to be inseparable from the immediate action of a living organism, but an extract may be obtained possessing all the powers of the rennet itself, although free from living organisms.

In all these latter actions the existing cause, although producing such great changes, is apparently itself unaltered, and seems to be capable even when present in small quantities of producing an almost unlimited amount of change. In the present state of our knowledge, considerable difficulty is experienced in explaining the apparent anomaly of a substance being unaffected itself and yet being the cause of change. An analogy which, although imperfect, may yet help us to form some

idea of the nature of such a decomposition, is to be found in actions such as that of metallic silver on hydrogen peroxide, a substance which may, for our present purpose, be regarded as a compound of water and oxygen. When silver in a fine state of division is thrown into the hydrogen peroxide, the latter is decomposed, evolving as may be seen in this cylinder large quantities of oxygen, but the silver itself remains absolutely unchanged.

From the various experiments which we have observed, it will at once become evident to you that the entrance of air or some other medium laden with the existing cause, is necessary for fermentation and putrefaction; and that if the air on entering be thoroughly purified no putrefactive change will take place. This, as we shall see later on, applies also to moisture, the absence of which is a certain condition for the prevention or retardation of putrefactive changes.

I have here on the lecture table a series of flasks containing putrescible liquids, these flasks having been carefully prepared either by plugging their necks with cotton wool or drawing out the neck and bending it in various ways, so that on entering the flask the air becomes purified or sterilised by depositing the existing germs in the cotton or in the bends of the tube. From the elaborate experiments of Pasteur and Tyndall, we have complete confirmation of the fact that pure air is in itself perfectly innocuous, and merely acts as a vehicle for the existing substance. One condition, however, of the greatest importance in carrying on the change after it has been excited, is the temperature of the decomposing fluid, extremes of either heat or cold arresting the action. We shall have to consider this more fully at a later point in the course in dealing with the preservation of food from putrefaction, and I will, therefore, at present merely show you the effect of cold in arresting the fermentation of ordinary sugar.

For this purpose, I take some of the liquid from our first experiment which you see is in an active condition, evolving large quantities of carbon dioxide gas, and pouring some of this into a fresh flask containing some lumps of ice, we find that the evolution of the gas gradually fails and finally ceases altogether.

From 0° to 20° C. fermentable changes gradually increase in intensity with the rise in temperature, becoming most active between 20° and 40°; on reaching 50° however, the growth of the ferment appears to be arrested. The same result is obtained if the temperature sinks below 0° C.

Having now considered some of the more general questions relating to those changes which ultimately produce putrefactive decomposition, I think it may be of interest to classify shortly the more important fermentable changes to which we have been alluding.

The more common cases of fermentation which we may mention as bearing more directly on our subject, are the following:—

1. Alcoholic.
2. Acetic (fermentation with oxidation).
3. Lactic.
4. Butyric.
5. Ammoniacal.

There are, as you know, many other forms of fermentation, such as mucous, pectous, and gallous, but the special considerations of their changes lie outside the scope of the present course.

Alcoholic Fermentation.

In this process we have the conversion of the juices of all sugar-containing plants, by reason of the glucose existing in this juice, into alcohol; this change, as is now established, taking place at a temperature somewhere between 20° and 25° C. The changes produced in the fermentation may be represented in the following equations:—

$$1.\ \underset{\text{Cane Sugar.}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{Glucose.}}{2\,(C_6H_{12}O_6)}.$$

$$2.\ C_6H_{12}O_6 = 2\,(C_2H_6O) + 2\,CO_2.$$

Acetous Fermentation.

In this, the change which occurs is the result of oxidation, and the chemical process is one evidently taking place in two stages. In the first, the alcohol becomes converted into a substance termed aldehyde, as may be seen in the expression—

$$\underset{\text{Alcohol.}}{C_2H_6O} + O = \underset{\text{Aldehyde.}}{C_2H_4O} + H_3O;$$

whilst the second portion of the change is the farther oxidation of this body into acetic acid.

$$C_2H_4O + O = \underset{\text{Acetic Acid.}}{C_2H_4O_2}.$$

To demonstrate such an oxidation to you, it is necessary to employ certain chemical means for the rapid oxidation of the alcohol, which may be done by bringing it in contact with potassium dichromate and hydrochloric acid, and distilling, On carrying out such a change

and condensing the product, we find it yields reactions by which it may be identified. Thus on adding to the product of our distillation some silver nitrate and ammonia, and warming the mixture, we obtain the reduction of the silver salt and a fine deposit of metallic silver. The substance here formed, or aldehyde ammonia, as it is termed, is employed for the coating of the interior of large globes, &c., with metallic silver.

The aldehyde, however, in ordinary acetous fermentation, never makes its appearance, as it at once, on its production, becomes converted into acetic acid—

$$C_2\,H_4\,O + O = C_2\,H_4\,O_2.$$

This further stage in the oxidation may be realised not by using free oxygen but by employing some method by which the oxygen may be brought into closer contact with the materials to be operated upon. This can be done by platinum black; and on the table you have an experiment in which you perceive that the alcohol is gradually being converted into acetic acid, and that the vapours filling the jar show a distinct acid reaction to the blue litmus paper placed round it. The platinum black, deprived of the air and oxygen between its particles during this reaction, becomes readily revivified on exposure to air, and a limited quantity of the platinum may therefore be employed to convert a large quantity of alcohol into acetic acid by means of the atmospheric oxygen. The properties of acetic acid thus formed are of considerable interest. Although generally met with as a liquid, it solidifies in its glacial condition, about 13° C., into beautiful, ice-like crystals, of which you have a specimen before you. On boiling the acid as I now do, it gives off a heavy vapour, which ignites on bringing a light to it, burning with a beautiful blue flame. In this combustion the acid is converted into carbon dioxide and water.

Lactic and Butyric Fermentation.

The common occurrence of the souring of milk, which I have already referred to at an earlier part of my lecture, is the result of a change in which we have the decomposition of milk sugar into lactic acid—

$$\underset{\text{Sugar of milk.}}{C_{12}\,H_{22}\,O_{11}\,H_2\,O} = \underset{\text{Lactic acid.}}{4(C_3\,H_6\,O_3)},$$

the milk sugar before passing into the form of lactic acid probably passing through that of glucose. In this case, however, the reaction ceases when the acidity of the fluid reaches a certain limit, and for any further change to take place, must be carried out in presence of chalk or sodium carbonate, which converts the lactic acid into calcium or sodium lactate; and allows the process to proceed to a further stage with the formation of calcium butyrate, thus:—

$$2\underset{\text{Calcium lactate.}}{\left\{Ca\,(C_3\,H_5\,O_3)_2\right\}} + H_2\,O = \underset{\text{Calcium butyrate.}}{Ca\,(C_4\,H_7\,O_2)_2} + Ca\,CO_3 + 3\,CO_2 + H_8.$$

Butyric acid is met with not only in rancid butter but also in the juice of muscular flesh; and with some other acids, such as valerianic and caproic, appears to be present in the perspiration of the skin, and thus to cause one of the disagreeable odours found in very close rooms.

The changes accompanying the refining of cheese are closely allied to butyric fermentation. This becomes apparent when we examine the composition of new and old Roquefort cheese. The refining of this particular cheese takes place only in one place, the air being there laden with the particular germs capable of producing this special change. The flavour of rancid butter differs from the high delicacy of the Roquefort cheese from the fact that in this latter the free butyric and other acids are neutralised by ammonia. Caseine being a highly nitrogenous substance, the nitrogen in the process of refining becomes converted into ammonia or some compound of it, whilst the carbon and hydrogen appear as a fat called oleine. This oleine oxidises so as to form the fatty acids, but these, instead of being in the free state as they are in rancid butter, are neutralised by the formation of ammonium salts.

Lactic acid may be recognised in combination by a violet colour which it gives with soluble cobalt salts. The solution, on stirring, deposits small dark pink crystals of cobalt lactate.

Citric acid, found in many plants, is converted much in the same way as the lactic acid into acetic and butyric acids. Many of you may have noticed the peculiar smell of butyric acid in the citric acid imported into

this country from Sicily; this is due to the calcium citrate undergoing a spontaneous decomposition of this nature, and it has been recommended to import the citric acid into this country as basic magnesium citrate, which apparently resists decomposition.

Division of the more common Products arising in Putrefaction.

The more common products arising from the changes we have examined, when they advance to the stage of putrefaction, may be roughly arranged in the following groups, commencing with those more complicated in their structure, and advancing to those of the simplest nature:—

Cadaveric alkaloids (Ptomaines).
Leucine. Tyrosine.

AMINES.

Ethylamine.	Methylamine.
Propylamine.	Amylamine.
Butylamine.	

FATTY ACIDS.

Formic.	Butyric.
Acetic.	Caproic.
Propionic.	and
Lactic.	Valerianic.

Carbon dioxide.	Ammonia.	Nitrous acid (?)
Hydrogen suphide.	Water.	Hydrogen.
Nitrogen.		

The so-called cadaveric alkaloids, or ptomaines, are supposed to exist and to be produced in animal bodies after death. The substances leucine and tyrosine arise from the decomposition of matter containing gelatine.

Of the amines—ethylamine, trimethylamine, and amylamine are found in putrefying animal substances, trimethylamine being also found in the roe of herrings and putrid urine. Methylamine, ethylamine, propylamine, butylamine, and amylamine are found among the products of the decomposition of bones.

These more complicated structures, after their first production, gradually undergo farther decomposition, with the formation of carbon dioxide and water; those containing nitrogen yielding ammonia, and those containing sulphur, hydric sulphide as well.

In my next lecture we will proceed to the consideration of some of the special chemical properties of the more important of those substances which I have enumerated to you as arising from putrefactive changes.

Miscellaneous.

THE WOODS OF SOUTH AFRICA.

The woods of the South African Continent deserve special attention. Little has yet been done in ascertaining their qualities and promoting their cultivation and preparation for external markets. What is known about them is conveyed in the following lists.

The trees found in the Zambesi district are as follows:—*Imbila*, is flexible, light, of medium quality, 15 ft. to 18 ft. long and 12 in. thick; *inhanpasse*, is 6 ft. long and 8 in. thick; *luabo*, is red, straight, heavy, good quality, 12 ft. by 10 in.; *metteral*, resembles light mahogany, good quality, 24 ft. by 12 in.; *mocasso-cassa*, reddish brown, hard, heavy, good for joinery, 18 ft. by 20 in. to 28 in.; *mocoza*, yellow, light, inferior, 35 ft. to 45 ft. by 36 in. to 48 in.; *mocua*, forked knees, good quality, 14 ft. by 8 in. to 10 in.; *mocunca*, heavy, crooked, 15 ft. to 18 ft. by 8 in. to 10 in.; *mocundo-cundo*, yellow, light, porous, used for masts, bark gives a febrifuge, 36 ft. by 40 in. to 60 in.; *monangare*, heavy, crooked, resembling rosewood, used by wheelwrights and for blocks, 18 ft. by 20 in. to 28 in.; *morrunda*, yellow, straight, light, used in shipbuilding, 15 ft. by 5 in. to 8 in.; *mouna*, red, straight, moderately heavy, good quality, 15 ft. by 12 in.; *mucorongo*, 18 ft. by 12 in.; *mucumite* or sandalwood, heavy, crooked, brown with light and dark shades, good quality, 6 ft. to 8 ft. by 8 in.; *mugunda*, yellow, straight, light, used in shipbuilding, 40 ft. to 60 ft. by 12 in. to 24 in.; *murumanhâma*, pale red, light, 18 ft. by 12 in.; *mussangara*, crooked, heavy, liable to split, 12 ft. by 10 in.; *pangira*, brown, porous, used in house and shipbuilding, 30 ft. by 26 in.; *pao-fava*, resembles light mahogany, good quality, 22 ft. by 12 in.; *pao-ferra* or ironwood, red, hard, heavy, used for furniture and trenails, good quality, 24 ft. by 8 in.; *pao-ferro* or *mais-is-curo*, dark brown, heavy, good quality, 24 ft. by 8 in.; *peam*, red, heavy, shrinks and warps, 18 ft. by 12 in. to 20 in.; *pingue* or *pao-preto*, resembles lignum-vitæ, 6 ft. by 6 in.; *raix-de-pingue* or *pao-preto*, heavy, black as ebony; *taxa*, yellowish, heavy, good quality, 20 ft. by 20 in. to 28 in.

The principal timber trees of the Transvaal and its neighbourhood are:—Assegai wood, Cape lance wood, or *oomhlebe* (*Custigia faginea*), extremely tough and elastic, used for wheelspokes and tool handles, grows 20 ft. to 30 ft. long by 24 in. thick; *bylsteel* or axe-handle, reddish, tough, elastic, used for tool-handles, 30 ft. to 40 ft. by 12 in.; *boekenhout* or African beech (*Myrsine melanophleos*), reddish brown, looks well polished, used for window-sashes, furniture, and wheel-spokes, 10 ft. to 20 ft. by 24 in.;

borrie, light yellow, used for waggon building, 10 ft. to 20 ft. by 24 in.; *boschlemon* or bush orange (*Grumella cymosa*), yellow, used principally for furniture, 15 ft. to 20 ft. by 24 in.; *bitter amandelen* or wild almond (*Brabeium stellatifolium*), red, used for waggon building, fit for ornamental joinery and turnery, polishes well, 20 ft. to 30 ft. by 48 in.; *bosch gorrah*, scarlet, close-grained and elastic, used for bows for waggon tents, would make a most beautiful furniture wood, 15 ft. to 20 ft. by 24 in. to 36 in.; *cedar boom*, resembles a light-coloured cedar, will not stand exposure, used for floors and roofs; *doornboom*, *kamelsdoorn*, *makohala*, or *motootla* (*Acacia giraffaes*), affords small wood for fencing, spars, fuel, and charcoal; *ebenhout* or Cape ebony (*Euclea pseudo-baenus*), black, solid, heavy, close-grained, used for furniture, ornaments, &c., 15 ft. to 20 ft. by 36 in.; *els* or alder, used for waggon building and farm fences; *essenhout*, Cape ash, or *oomnyamati* (*Eckebergia capensis*), dark drab, principally used for furniture, looks well when polished, 15 ft. to 30 ft. by 48 in.; *geelhout opregte* or upright yellow wood (*Podocarpus thunbergii*) and *geelhout outeniqua* or yellow wood (*P. elongatus*), or *oomkoba*, common yellow timber, extensively used in house building, warps in seasoning, is apt to split in nailing, and suffers dry rot if not freely ventilated, 50 ft. to 70 ft. by 48 in. to 72 in.; *harde hout* or hardwood, used for walking-sticks and tool-handles; *hoenderspoor*, *doornpeer*, or cockspur (*Phoberus zeyheri ?*), white, extremely hard, close, and durable, used for waggon-building, 15 ft. to 20 ft. by 36 in.; *kafirboom*, *oomsinsi*, or *limsootsi*, soft, light, porous, splits easily, used for shingles, being slow to ignite; *kajaten hout*, or Cape teak (*Canthium*, *sp.*), fine black, hard, tougher than oak, used for furniture, 20 ft. by 48 in.; *kastanie*, or wild chestnut (*Colodendron capense*), whitish, elastic, soft, pliable, used for waggon-tent bows and domestic utensils; *Knopjes doorn*, or *paardepram* (*Fagarastrum capense*), yellow, hard, close, used for yokes, axles, and tools, 8 ft. to 10 ft. by 10 in. to 18 in.; *Koolboom hout*, or cabbage tree, light yellow, soft and woolly, used for domestic vessels, 15 ft. to 20 ft. by 24 in.; *nieshout*, sneezewood, or *oomtata* (*Pteroxylon utile*), whitish yellow, used for waggon-building, little affected by moisture, handsome, strong, durable, takes fine polish, 30 ft. by 36 in.; *olyven hout*, wild olive, or *kouka* (*Olea verrucosa*), dark brown, compact, heavy, handsome when polished, good for waggon work, 10 ft. to 12 ft. by 12 in.; *peer* (*geelpeer*), yellow pear, or *kwa*, whitish yellow, mostly used for furniture, 10 ft. to 15 ft. by 12 in.; *peer* (*hardepeer*), or hard pear (*Olinia capensis*), white, durable, tough, adapted for spokes, axles, and poles, resembling European birch, 10 ft. to 15 ft. by 12 in.; *peer* (*roodepeer*), or red pear (*Phoberos Ecklonii*), red, heavy, close, used by wheelwrights, takes a polish fit for furniture, 20 ft. to 40 ft. by 48 in.; *peer* (*witpeer*), or white pear (*Pterocelastrus rostratus*), white, heavy, strong, generally used for waggon-building, 15 ft. to 36 ft. by 48 in.; *roodebessie*, or redberry (*Pappea capensis*), yellow-brown, hard, tough, perishes on exposure, good for furniture, 15 ft. to 20 ft. by 12 in.; *roode hout* or redwood (*Ochnea arborea*), reddish, heavy, tough, chiefly used for waggon-poles, tools, and axles; *roode melkhout*, red milkwood, or *oomtombi* (*Sideroxylon inerme*), light yellow, very hard, durable, little affected by damp, used for mills, waterworks, &c., 10 ft. to 15 ft. by 24 in.; *saffraan hout* or saffron wood (*Elæodendron croceum*), reddish, fine-grained, hard, used in waggon-building, bark good for tanning and dyeing, 20 ft. to 30 ft. by 36 in.; *salie* or salie wood (*Buddleia salviæfolia*), yellow, hard, tough, suited for waggon-work, gunstocks, tools, and rural utensils, 12 ft. to 15 ft. by 12 in.; *spekerhout*, pale red, very durable in moist ground, 15 ft. to 20 ft. by 24 in.; *stinkhout* (*camdeboo*), stink wood or Cape walnut (*Rhamnus celtifolia*), light brown, tough, used for yokes, tools, and gunstocks, 20 ft. to 30 ft. by 48 in.; *stinkhout* or cannibal stinkwood (*Oreodaphne bullata*), light yellow with black core, used for furniture and waggons, 30 ft. to 40 ft. by 24 in. to 36 in.; *stinkhout* (*witte*) or white stinkwood (*Laurus bullata*), white, used for gun butts and tools, 20 ft. to 30 ft. by 48 in.; *terpentyn hout*, *olifants hout*, turpentine wood, or elephant wood, yellow with black core, used for furniture and waggons, 20 ft. to 30 ft. by 24 in.; *tolbal*, white used for long waggons, 15 ft. to 20 ft. by 12 in.; *umcheni*, mahogany colour, used for windows and doors, but would be excellent for good cabinet work, crooked and small sized; *umghni*, light yellow, very close grained and tough, well adapted for poles, spikes, &c., contains a resinous tar, 20 ft. to 30 ft. by 24 in. to 36 in.; *vyg*, *wilde vyg*, or wild fig (*Urostigma nataliensis*), light yellowish brown, soft and woolly, tough, does not shrink or warp, 50 ft. to 80 ft. by 48 in. to 72 in.; *wilge boom* or willow, a light wood, of little value except for making charcoal; *witgatboom* (*Capparis albitrunca*), white, tough, used for yokes and agricultural purposes, 10 ft. to 15 ft. by 12 in.; *yzer hout*, ironwood, *hooshe* or *tambooti* (*Olea lauriflora*), black, hard, close-grained, heavy, used for furniture, tools, waggons, &c., looks well when varnished, 20 ft. to 30 ft. by 24 in. to 36 in.; *yzer hout* (*wit*) or white ironwood (*Asaphes undulata*), white, hard, very tough, used for waggons, ploughs, and implements, 20 ft. to 30 ft. by 24 in. to 36 in.; and *zwartbast* or black bark (*Rogena lucida*), whitish, hard, tough, used for waggon work, 15 ft. to 20 ft. by 12 in. to 24 in.

In addition, there are many other trees and arborescent shrubs whose wood is used for making clubs, weapons of war, and domestic utensils, as well as for firewood, such as the *buffeldoorn* (*Burchellia capensis*), the *katdoorn* (*Scutia capensis*), the *spekboom* (*Pterocelastrus typicus*), several kinds of *taaibosh* (*Rhus spp.*), the *travenbosh*, the *wachteenbeetje*, and the *Zuikerbosh* (*Protea sp.*).

ANNATTO CULTIVATION IN BRAZIL.

Consul Clayton, of Pará, says that the name *Bixa* which has been given to a genus comprising four species of tropical shrubs or small trees belonging to the natural order *Flacourtiaceæ*, is the native name of the Indians of Darien for one of these species, *Bixa orellana*. The Brazilian name of the plant is *urucuara*, or plant bearing *urucu*, the latter being the Brazilian name of the pigment known as annatto. There are probably two species in Brazil, *Bixa orellana* and *Bixa urucurana*, the former being indigenous to the West Indies, but the two are very much alike, and it is almost impossible to say which species is grown in the Amazon valley. The species usually considered as producing annatto is *Bixa orellana*. This species is a small tree or large shrub growing from 15 to 25 feet in height, bushy from the root and forming a single stem. The leaves are broad, heart-shaped, and pointed. The flowers, which are rose-coloured or white, and somewhat resembles apple blossoms, are produced in large bunches on the ends of the young branches. The fruit is heart-shaped, about an inch long, red or greenish yellow, according to the variety, and is covered with stiff prickles. When dry it splits in two, showing the seeds in a perpendicular row on each side. These seeds, which are very numerous, are embedded in a red waxy plant. Consul Clayton says he has never known the plant to be met with growing wild, although it is often found many miles from any habitation, but it marks the site of a former house or plantation. The two species grown in Brazil only differ in the colour of the flower and fruit, which in the one are pink and red respectively, while the other has white flowers and greenish yellow fruit. The colouring matter appears to be of the same shade in both, and there is no appreciable difference between the two kinds in the quantity produced. The tree is cultivated in the whole Amazon valley, and is always found around the houses of the Indians. It appears to attain a great age, but never becomes very large, the trunks of the largest measuring about 18 inches in diameter at the base. The wood is light and is considered of no value. The tree is subject to no diseases, and is not attacked by insects. It grows freely in any soil, and no cultivation is necessary except to shade and keep down the weeds around the young plants until they become well established. The trees must be grown in full sunshine, as they do not bloom when grown in the shade. Propagation in Brazil is effected only by seeds, and the trees begin to bloom when they attain the height of about 10 feet, which is in about three years from the time of sowing. In a cooler and drier climate, where growth would not be continuous, a far longer time would be necessary. In Brazil the fruit matures rapidly after flowering, and is ready to gather in about two months; if gathered as soon as mature, the tree at once makes fresh growth, and fresh flowers and fruit. The practice, however, is to allow the fruit to remain on the tree until required for use; it dries, and as the capsule does not readily burst, the seeds remain for a long time in good condition. Within a few months the tree is again in bloom. The preparation of the pigment is very simple. The seeds are macerated in water until the pulp, which is readily separated, is removed. The water is then passed through a strainer made of strands of palm to remove the seeds and fibre, and is then evaporated in the sun until the mass becomes thick. This mass is then rolled in leaves, producing roll annatto, or it is evaporated to dryness, and made into cakes producing roll annatto. Sometimes the seed as taken from the pod is simply dried for market, and forms what is known as *uruca em grao*. The pigment is extensively used by the Indians in dyeing the threads of hammocks, and by the wild Indians for painting their bodies, the latter mixing it with turtle oil, or the fat of the *peixe-bois* (manatee). In Pará it is sometimes used to give colour to cooked rice, and an infusion of the leaves drunk when hot is considered a remedy for jaundice. In conclusion, Consul Clayton says that he has been informed by an American traveller who has explored the Amazon valley from Iquitos, Peru, that he had never seen in any of his travels any systematic culture of the *urucu*, and very little of it comes to the market from the territory through which he had passed. He noticed that each house or village had enough trees for the use of the inhabitants, but, as far as he observed, there was no disposition to make the *urucu* an article of trade.

Obituary.

General Hyde.—Major-General Henry Hyde, Inspector - General of Railway Stores to the India-office, died at Caterham, on Friday, 23rd inst. General Hyde joined the Bengal Engineers in 1844, and served in the Punjaub in 1848 and 1849, taking part in the storming and capture of Mooltan and the battle of Goojerat. He retired in 1878. He was elected a member of the Society of Arts in 1876, and on the occasion of the reading of Dr. Forbes Watson's paper on "The Preparation and Use of Rheea Fibre," December 10th, 1883, he took the chair.

Thomas Routledge.—Mr. Routledge, a member of the Society of Arts of more than thirty years standing, died at the Westminster Palace Hotel, on Saturday, 17th inst. Mr. Routledge was not originally a paper-maker, but in 1856 he took a mill at Eynsham, near Oxford, where, after obtaining a patent, he succeeded in making paper from esparto grass. The number of the *Journal of the Society of*

Arts for November 28th, 1856, containing Dr. Forbes Royle's paper on "Indian Fibres," was printed on paper made from esparto at Eynsham Mills, and supplied by Mr. Routledge. About 1862, he acquired the Ford Paper-mills, near South Hylton, Sunderland, and in 1864, he converted the business into a company, under the title of the Ford Works Company, Limited, of which he continued to be the managing director down to the time of his death. For some years he was the only paper manufacturer in England who used esparto, but after a time it came into general use. The amount of the imports in 1856 was only 50 tons, but by 1864 it had grown to 50,000 tons, and in 1886 the imports exceeded 200,000 tons. Mr. Routledge succeeded in proving the suitability of bamboo as a paper-making material, and published a pamphlet on the subject in 1875, which was printed on paper made from bamboo. Mr. Routledge took the greatest interest in all attempts to introduce new paper-making materials, and he experimented upon many vegetable fibres for this purpose. He was a contributor to the *Journal*, and joined in most of the discussions at the meetings when subjects connected with paper-making materials were brought forward.

General Notes.

The World's Steamers.—The number of steamers existing in the world last year was estimated at 9,969, of an aggregate burthen of 10,531,843 tons. The corresponding number of steamers existing in the world in 1885 was estimated at 9,642, of an aggregate burthen of 10,291,241 tons. The total of 9,969 steamers representing the world's steam shipping in 1886, was made up as follows:—Iron steamers, 8,198, of an aggregate burthen of 8,911,406 tons; steel steamers, 770, of an aggregate burthen of 1,206,962 tons; composite steamers, 109, of an aggregate burthen of 32,820 tons; and wooden steamers, 822, of an aggregate burthen of 380,655 tons. Of the steamers afloat in 1885, 5,792 were owned by the United Kingdom and its colonies, their aggregate burthen being 6,595,871 tons. The other countries of the world owned steamers as follows, last year:—Germany, 579; France, 509; Spain, 401; the United States, 400; Norway, 287; Russia, 212; Denmark, 200; Italy, 173; Holland, 152; Brazil, 141; Japan, 105; Greece and Turkey, 82 each; Belgium, 68; Chili and the Argentine Republic, 43 each; China and Portugal, 27 each; Hawaii, 21; Mexico, 15; and miscellaneous, 50. It will be seen that, notwithstanding the great depression prevailing in steam shipping, the number of steamers afloat has increased to the extent of 327, as compared with 1885.

King's College, London.—During the Session 1887-8 (commencing October 10th), in the Evening Class Department, "Metallurgy" (Professor: A. K. Huntington; Demonstrator: W. G. McMillan), a course of lectures on "The Properties of Metals and Alloys, and their Uses in the Arts," will be given on Monday evenings, from 8 to 9, and will include the study of the various metals in common use. Especial attention will be devoted to the metallurgical requirements for the examinations of the City and Guilds of London Institute in metal-plate work, plumbing, and iron and steel. A course of lectures will also be given by W. G. McMillan on "Fuels, their Uses and Economy," on Monday evenings, from 7 to 8, and will include the subjects required for the City and Guilds Institute examination in fuel. The course will open with a free public lecture, "A Brief Retrospective Glance at the History of Artificial Heating," to be given at 7 p.m. on Monday, October 10th. A class of practical metallurgy will be held on Fridays, from 7 to 9 p.m., in the metallurgical laboratories, to enable students to become practically acquainted with the properties of metals, and the general methods of assaying and medical testing, &c.; and also, if they desire it, students may prepare for the examination of the Science and Art Department in practical metallurgy. A special course of ten lectures on "The Manufacture and Use of Iron and Steel," will be given by the Demonstrator at 7 p.m. on Thursday evenings, commencing on Thursday, October 13th.

German Beer Statistics.—The official returns quoted from the *Wochenschrift für Brauerei* for the first six months of the current year show the export of a total weight of 64,079 tons, being an excess of 2,789 tons as compared with the same period of 1886, but representing a decrease of 13,281 tons as against the first six months of 1885. There has been a progressive export during the earlier part of the last three years to Hamburg, Bremen, Austria, Switzerland and Sweden, while deliveries to France and Belgium have fallen off. There is an increase this year in exports to Holland and Denmark. Trade with Great Britain and Russia has been larger than in 1886, although not up to the mark of 1885; while there is a decrease in shipments to the United States, Italy, and Spain, as compared with 1886. Imports from Austria were for the three six-monthly periods—5,433, 6,236, and 6,829 tons; and from Great Britain 404, 441, and 504 tons. Thus it will be seen imports have, on the whole, been increasing. The imports from Austria have always been much in excess of the exports to that country, but formerly imports from Great Britain were inferior in quantity to the direct exports thither. The quantities were as nearly as possible equalised during the period under review, but it is conjectured that a portion of the beer nominally exported to the Hamburg district was subsequently forwarded to England.

Journal of the Society of Arts.

No. 1,820. Vol. XXXV.

FRIDAY, OCTOBER 7, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF SUBSTANCES TAKING PART IN PUTREFACTION AND ANTISEPSIS.

By John M. Thomson, F.R.S.E., Sec.C.S.,
Demonstrator of Chemistry, King's College, London.

Lecture II.—Delivered May 9th, 1887.

Having considered in my last lecture some of the more general questions relating to the chemical changes going on during the process of fermentation, and the more advanced changes of putrefaction, I pass this evening to the consideration of the special chemical properties of some of the more important compounds formed in such changes.

I would remind you that these compounds may be roughly divided into two classes; the first containing the more complicated bodies, such as the alkaloids and ammonia derivatives, the second the farther and less complicated substances into which the bodies of the first class may be converted, as carbon dioxide, ammonia, water, and certain of the elementary gases.

It is not easy to illustrate to an audience such decompositions satisfactorily or rapidly, but a certain analogy may be drawn from the decomposition, or "destructive distillation" of coal, which, on the application of heat in a vessel from which air is excluded, yields an enormous variety of substances. On the table you have an arrangement showing the distillation in operation. The coal is placed in a glass retort, which is carefully heated with the flame of a gauze burner. The tar and ammoniacal liquor are condensed in a globular flask attached to the retort; whilst the carbon dioxide and hydric sulphide produced may be recognised by placing a little lime water and some solution of lead acetate in two U-shaped tubes attached to the globular receiver. The inflammable gases are collected in a bell jar, into which they are led by a delivery tube from the tubes containing the lime water and lead solution. This experiment shows us certainly but a very few of the products derived from the decomposition of coal; but when we examine the diagram on the screen which contains the more important of these products, it is evident that the distillation of such a substance gives us a very fair instance of a change such as takes place in the putrefactive decomposition of a substance.

The more important substances produced in this decomposition may be arranged in the following groups:—

Products from the Destructive Distillation of Coal.

Gases.		Liquids.		Solids.	
Hydrogen	H.			Naphthaline....	$C_{10}H_8$.
Marsh gas	CH_4.	Benzene.........	C_6H_6.	Anthracine	$C_{14}H_{10}$.
Olefiant gas	C_2H_4.	Toluene	C_7H_8.	Paraffin........	$C_{16}H_{34}$.
Acetylene	C_2H_2.			Coke..........	C.
Nitrogen	N.	Aniline	C_6H_7N.		
Ammonia	NH_3.	Quinoline	C_9H_7N.		
		Hydrocyanic acid ..	CHN.		
Carbonic oxide..	CO.	Water............	H_2O.		
Carbon dioxide..	CO_2.	Acetic acid........	$C_2H_4O_2$.		
		Carbolic acid	C_6H_6O.		
Hydric sulphide ..	H_2S.	Carbon disulphide	CS_2.		

In putrefactive changes taking place in animal matter, we find certain substances produced which are not contained in the products of vegetable decay. This, as is well known, arises from the presence of phosphorus in animal bodies, which, on the decomposition

of the material, unites with hydrogen, and yields a gaseous product, phosphoretted hydrogen or phosphine, PH_3. Nitrogen being also an invariable constituent of animal substances, the formation of ammonia is always observed in the decomposition of such matter. This you will see by the distillation before you of some chips of horn or shreds of bladder, when, as you perceive, the gas derived from the distillation rapidly changes the red litmus in the receiver to a blue colour, and the yellow turmeric to a deep brown.

The farther and more complete resolution of materials into carbon dioxide and water is best seen by the combustion of a candle. By the arrangement before you a candle is kept burning in a current of air, the moisture produced being collected in a large glass tubular receiver. If the air be drawn through the apparatus by an aspirator, the carbon dioxide produced will be drawn through a vessel containing lime water, when its presence will be indicated by the formation of a deposit of calcium carbonate.

Referring now to the special properties of the substances found in putrefactive changes, it would be impossible in the time at our disposal to take into consideration each individual body. I must, therefore, content myself with bringing before you only those substances which are most commonly met with, and which may be more familiar to you by name.

Cadaveric Alkaloids, or Ptomaines and Leucomaines.

The group of substances most complicated in their nature which are found in decomposing changes are perhaps those containing nitrogen and phosphorus. Of these the cadaveric alkaloids or ptomaines have been recognised as being produced after death in decomposing human bodies. They are substances difficult of examination, and at present considerable doubt exists as to their exact nature and composition. They appear to be produced moderately soon after death, but are soon again decomposed into more simple substances, and are, therefore, difficult of extraction. Observations have been made upon them, amongst which more especially may be mentioned those of Franceur Seleni, who made a considerable study of the methods of extracting these poisonous substances by different solvents, and observed their behaviour with many common reagents for alkaloids. He also succeeded in separating ptomaines containing arsenic from the decomposing bodies of people poisoned by compounds of this element. It has been shown by Lombrose and Erba that poisonous substances resembling ptomaines are produced during the putrefaction of maize and other vegetables.

In connection with the decomposition of animal matter, it is found that the various portions differ very considerably in their tendency to decay. The more complicated structures, such as the blood, muscular tissue, &c., undergo putrefaction much more rapidly than the fatty tissue, which latter, through the influence of moisture, becomes converted gradually into mixtures of palmitic and margaric acids, resisting for a considerable time the process of decay. It is curious to observe also that certain parts, although containing large quantities of nitrogen, such as the nails, horns, hair, &c., resist decomposition for a long period of time. These latter substances are very closely allied in their composition to a well-known animal substance, gelatine, which is itself prone to decomposition.

By the exhaustion of certain portions of meat, such as cartilage, tendon, &c., with water, two substances formerly confused together are obtained. These are gelatine ($C_{41}\,H_{67}\,N_{13}\,O_{16}$) and chondrine ($C_{36}\,H_9\,N_9\,O_{16}$). In its decomposition, and by the action of various acids and alkalies, gelatine becomes converted into two bases, one glycocine ($C_2\,H_5\,NO_2$) and the other leucine ($C_6\,H_{13}\,NO_2$). The composition of glycocine shows it to be the same as, or isomeric with, a substance perhaps known to some of you, nitrous ether ($C_2\,H_5\,NO_2$); whilst leucine would correspond to the nitrous ether of caproic or hexylic alcohol, thus showing a connection with one of the series of fatty acids which are also found and have been already mentioned among the products of putrefactive decompositions.

Ammonia and Ethylated Ammonias.

The somewhat simpler substances which are produced in the putrefaction of nitrogenous substances constitute a group of bodies interesting not only from their formation in such changes, but also from the circumstance of their relation to the simplest of all nitrogen compounds, namely, ammonia.

Those of interest to us more especially are termed ethylated ammonias, and are formed, as is said, on the type of ammonia by the replacement of the various atoms of hydrogen contained in that substance, thus:—

Ammonia.	Ethylamine.	Duthylamine.	Triethylamine.
$N\left\{\begin{matrix}H\\H\\H\end{matrix}\right.$	$N\left\{\begin{matrix}C_2H_5\\H\\H\end{matrix}\right.$	$N\left\{\begin{matrix}C_2H_5\\C_2H_5\\H\end{matrix}\right.$	$N\left\{\begin{matrix}C_2H_5\\C_2H_5\\C_2H_5\end{matrix}\right.$

Ammonia itself is well known to most of you so far as its common properties are concerned, but there are one or two interesting points connected with its oxidation into nitrous and nitric acids which, as they bear upon our subject, I should wish to bring them before you.

Although ammonia is constantly passing into the atmosphere from the putrefaction of animal and vegetable matter containing nitrogen, yet its quantity, under ordinary conditions, is not large, rarely exceeding 1-100th of a grain per cubic foot. This probably arises from the fact of its solubility in water, which is a very marked property of the gas. I have here before me a globular flask filled with ammonia gas, with its neck dipping in a cup of mercury placed in a larger vessel filled with water tinged with red litmus; on raising the flask out of the mercury, which is acting as a valve, you at once perceive the rise of the liquid in the flask, the absorption taking place with extreme rapidity when the solution reaches the globular part of the flask. The red litmus solution, as you see, becomes at once changed to blue, showing the alkaline nature of the solution produced. This solution of the gas in water constitutes, as many of you know, the "liquor ammoniæ" of trade, one volume of water being capable of absorbing 700 volumes of the gas at ordinary temperature and pressure, becoming one and a half volumes after absorption.

Another property of ammonia, of interest to us, is the combustion of the gas in air or oxygen, and its indirect oxidation by other means. It is a feebly combustible gas, burning at the mouth of the bottle which I am now holding, only when the taper is held actually at the mouth of the vessel. A more convenient method for carrying out its full combustion is to supply the jet of ammonia with a current of oxygen gas, when you perceive the gas burns with a peculiar greenish-yellow flame, which at once becomes extinguished on cutting off the current of oxygen. In this combustion probably the ammonia becomes entirely decomposed, water and nitrogen gas being the only products.

If, however, a few drops of the strongest liquor ammoniæ be placed in the bottom of a wide-mouthed flask, and a current of air from an ozonising apparatus be carried through the flask, white fumes of a solid substance—ammonium nitrite—make their appearance. The same change may be brought about by placing in the flask of air and ammonia a red-hot coil of platinum wire, such as you see in the flask on the table. Thick clouds of ammonium nitrite, and sometimes red vapours of nitrous anhydride (N_2O_3) are formed.

$$2\,NH_3 + O_3 = NH_4NO_2 + H_2O.$$

Certain materials in a finely divided condition, or when coating or covering other substances, have a peculiar influence in promoting such changes, and I can show you, experimentally, the conversion of ammonia into nitrous and nitric acids by means of one such material, namely, asbestos coated with finely divided platinum. The platinised asbestos is placed in a long hard glass tube, which has a piece of red and blue litmus paper at either end. On passing a slow current of air from a gasometer through a bottle containing some very dilute ammonia solution, and then over the platinised asbestos heated by a burner, the ammonia becomes converted into the nitrogen acids. If the air is passed over the asbestos from the end of the tube containing the red litmus paper, this will become blue from the unchanged ammonia, whilst the blue litmus at the other end will become red from the nitrous acid produced.

This change of ammonia into nitrous and nitric acid is favoured by the presence of strong bases, and has received the name of "nitrification." It plays a most important part in the formation of the large beds of nitre which are found in warm countries, such as Chili and Peru, and appears to be facilitated, if not entirely dependent, on the development of a germ producing a fermentation like the yeast cell. Its action has been examined by Mr. Robert Warington with some very interesting results. The ferment is abundant in the soil, in sewage, and in contaminated water, and is peculiar in its action; in cold dilute solutions of ammonia salts, or in the dark apparently only nitrates are formed, but in sunlight, and with strong solutions, nitrites are also produced.

We shall find, at a later period, when dealing with the properties of charcoal as an absorbent for noxious gases, that the charcoal employed in the sewer ventilators is highly charged with nitrates, probably produced in the pores of the charcoal by a process of slow oxidation analogous to that of the platinised asbestos just described.

With regard to the ammonia bases formed by the replacement of one or more atoms of hydrogen in ammonia by an alcoholic radical, the following Table gives the source from which the different members are derived, with the names and formulæ of the compounds :—

Putrefying flour	Ethylamine	$NH_2 . C_2H_5$
	Amylamine	$NH_2 . C_5H_{11}$
	Trimethylamine	$N . (CH_3)_3$
Herring roe / Putrid urine.	Trimethylamine	..
Destructive distillation of bones.	Methylamine	$NH_2 . CH_3$
	Ethylamine	$NH_2 . C_2H_5$
	Propylamine	$NH_2 . C_3H_7$
	Butylamine	$NH_2 . C_4H_9$
	Amylamine	$NH_2 . C_5H_{11}$

Ammonia, as well as these more complicated ammonia bases, is characterised by an extremely delicate reaction with Nesler's reagent, which consists of a strongly alkaline solution of the double iodide of mercury and potassium. The smallest traces of either ammonia or of the bases give with this test a distinct brown or dark yellow colouration.

Phosphine or Phosphoretted Hydrogen (PH_3).

This substance is produced in the decay of material rich in phosphorus, and, like trimethylamine, apparently exists in putrid fish. It is a gas which possesses the curious property of spontaneously catching fire when brought in contact with air, and its production in decaying fish may probably account for the phosphorescent appearance which the material is said to have. Its spontaneous inflammability is easily shown to you on preparing a small quantity of the gas in this retort, by boiling together phosphorus and caustic soda. You will perceive as the temperature rises bubbles of gas come off which burst inside the retort; in consequence of this I keep the mouth of the retort above water till it becomes perfectly filled with the gas and a flame is burning quietly at the mouth. On depressing the mouth of the retort under the water in the trough, you see that each bubble as it comes to the surface bursts with a slight explosion, forming beautiful rings of smoke consisting of phosphorus pentoxide. When allowed to stand at a low temperature, a liquid phosphide of hydrogen is produced, and if this latter be exposed to light, a solid phosphide has been removed from the gaseous phosphine, it then loses its property of spontaneous inflammability.

Much interest attaches to phosphine, as it may be considered as the chemical analogue of ammonia, and a body in which the hydrogen may be replaced by certain compound bodies, just as we had in the case of ammonia forming very strong organic bases. There is considerable probability that these phosphorus compounds are produced along with phosphine in the decay of material containing phosphorus.

The following formulæ show the analogy between ammonia and phosphine, and the bases referred to :—

$$\text{Ammonia } N \begin{cases} H \\ H \\ H \end{cases} \qquad \text{Phosphine} \ldots\ldots P \begin{cases} H \\ H \\ H \end{cases}$$

$$\text{Triethylamine } N \begin{cases} C_2H_5 \\ C_2H_5 \\ C_2H_5 \end{cases} \qquad \text{Triethylphosphine } P \begin{cases} C_2H_5 \\ C_2H_5 \\ C_2H_5 \end{cases}$$

Other Hydrogen Compounds Produced in Putrefactive Changes.

In such a group may be arranged such of the products as elementary hydrogen, hydric sulphide (H_2S), and some of the hydrogen compounds of carbon, more notably marsh gas (CH_4) and olefiant gas, or ethylene (C_2H_4). Although ammonia and phosphine might also have been placed in this group, I have preferred to separate them from it, on account of their relations to the more complicated substances, as the compound ammonias and the organic alkaloids.

The majority of the decomposing changes taking place on material containing much hydrogen associated with other bodies is produced by what may be termed the hydrolysis of the substance. Such changes may be illustrated to you more markedly when the hydrogen is in what is called the nascent condition; this name being applied to the condition of an elementary gas just at the time of its liberation from a state of combination, at which moment it exhibits much greater chemical activity.

All of you, I think, must be aware of the inflammable nature of hydrogen, and of its gaseous carbon compounds; but I can show you, in an experiment which I have on the table, not only its inflammability, but also its power of uniting with other substances at the moment of, or during the process of, its liberation from the substance with which it was originally combined. I evolve here in the

usual manner some hydrogen gas, by pouring dilute hydrochloric acid on metallic zinc, and when the generating flask is filled with gas, I light the hydrogen. You see that it burns at the jet with the characteristic, almost colourless flame. If now I drop through the thistle funnel attached to the apparatus a single match head, you perceive that, after a few seconds, the flame becomes tipped with a faint greenish-yellow colour, showing the evolution of small quantities of phosphine, the substance we have already discussed. The nascent hydrogen here combines with the phosphorus. From this experiment it is easy to understand how readily such hydrogen compounds may be formed in processes of decomposition.

The chief action of hydrogen in these changes is one of reduction, and this reducing action is well seen by bringing nascent hydrogen in contact with a compound of tungsten. In this vessel we have a solution of sodium tungstate; if now we add to this some zinc and sulphuric acid, so that hydrogen may be evolved, we find a beautiful blue colour developed in the fluid. This colour is due to the formation from the tungstic acid of a blue oxide ($WO_2 . WO_3$).

The most important hydrogen compound which comes under our notice is hydric sulphide or sulphuretted hydrogen gas (H_2S), a distinctly poisonous gas produced in the putrefaction of eggs by the decomposition of the albumen in the yolk, which substance has already been pointed out as containing a considerable quantity of sulphur. Hydric sulphide exists as a gas, with a most disagreeable smell, and is found in considerable quantities in the gas issuing from the sewers. The detection and destruction of this gas is therefore a matter of great importance, and we shall later on in the course have to speak of the power exercised by charcoal in decomposing the gas. Its detection is readily effected by the black sulphide it gives with lead or silver salts, and the usual method for recognising it is to bring paper moistened with silver nitrate or lead acetate in contact with the suspected gas, when it at once becomes blackened, as you now see in the test before you. A more delicate reaction for sulphur compounds in an alkaline condition is to be found in a beautiful purple colour which they give with sodium nitroprusside. To this large jar of water I add a small quantity of the nitroprusside solution, and then a drop or two of ammonium sulphide, when you perceive at once the beautiful colour which is produced. It is stated that the quantity of sulphur present in a single hair may be detected by this test.

The gas is soluble in water, and combustible, undergoing decomposition in its combustion into water and sulphurous acid gas.

$$H_2S + O_3 = H_2O + SO_2$$

Small quantities of sulphuric acid are also produced. This change is almost the same as takes place in its decomposition in the pores of the charcoal employed in the air filters.

Hydric sulphide is a highly poisonous gas in the case of warm-blooded animals; cold-blooded ones appear to be unaffected by it The gas causes fainting when inhaled in quantity, and produces great depression of the vital energy when breathed for any length of time, even when in a largely diluted condition. The poisonous action of the gas is apparently related to the rapidity of the circulation of the blood.

The gaseous compounds of hydrogen and carbon form a most important class of substances produced in decay. The simplest member in the group, marsh gas (CH_4), is found associated with carbon dioxide, in the bubbles of gas which are obtained on disturbing the sediment at the bottom of stagnant pools. It is there formed by the decomposition of vegetable matter falling into the pool; and, as marsh gas and carbon dioxide are given off in the gradual transformation of vegetable matter into coal, we are not surprised to find large quantities of the former gas issuing from fissures in coalpits when the seams are newly opened.

Like hydrogen itself, the gaseous hydrocarbons are combustible, burning with a more or less luminous flame according to the relative amount of carbon which each contains. We have in these two jars marsh gas (CH_4), and olefiant gas (C_2H_4), and on igniting each, you see that the flame of the olefiant gas is considerably more brilliant than that of the marsh gas, as it contains the proper amount of carbon to render the flame luminous; the marsh gas, on the other hand, contains too little carbon in proportion to the hydrogen to yield a satisfactory luminous flame.

The second hydrocarbon I mentioned, olefiant gas, or ethylene (C_2H_4), derives its name from its property of uniting directly with the elements chlorine and bromine, forming with the first of these a compound, Dutch liquid, or ethylene dichloride ($C_2H_4Cl_2$). The formation of this can easily be shown by mixing together in a cylinder over water equal volumes

of ethylene and chlorine, when you see that the two gases gradually unite, thick oily drops of a liquid forming on the sides of the vessel; these gradually collecting together, run down the sides of the vessel, forming a layer on the top of the water as it rises in the cylinder.

This combination of ethylene with chlorine or bromine is made use of in the determination of the illuminating agents in ordinary coal gas. For this purpose, a bent graduated tube, the shorter end of which is opened, is filled with the gas to be examined; a drop or two of bromine is then poured into the open limb, and the tube well shaken. Absorption having taken place, the contraction in volume is noted, this contraction corresponding to the amount of illuminating gases. For exactness in the operation daylight must be excluded, so as to prevent the union of the free hydrogen in the coal gas with the bromine.

When ethylene is mixed with twice its volume of chlorine, and a light applied, we have a different result, attended with the total decomposition of the ethylene and the formation of hydrochloric acid and free carbon. I have in this tall jar such a mixture, and on the application of a light you perceive a red flame passing down the cylinder with a peculiar booming sound during the combustion. The change taking place may be expressed thus:—

$$C_2H_4 + Cl_4 = 4\,HCl + C_2.$$

We come now to the last group of substances to which I think it necessary to draw your attention, namely, the compounds of carbon with oxygen.

Carbon Dioxide (CO_2) and Carbonic Oxide (CO).

I have already made allusion to the first of these as one of the commonest of the final products of putrefactive decomposition, and in my first lecture I demonstrated to you its formation in considerable quantities in the fermentation of sugar by yeast. The other great sources of the gas are the processes of respiration in animals, and the combustion of carbonaceous matter in which the oxygen of the air becomes converted into carbon dioxide. In the former of these changes we have the well-known difference between plants and animals; as during sunlight the plants absorb the carbon dioxide evolved by the animals, decomposing it, and returning the free oxygen gas to the atmosphere. When the plant dies, however, the carbon stored in its tissues is again returned to the air in the form of CO_2 during the decay of the plant.

Carbon dioxide is always, therefore, formed in ordinary air, to a greater or less extent, sometimes, as in close places, reaching a very high per-centage. The normal quantity generally found in good air is about 4 volumes of CO_2 in 10,000 volumes of air. It is also found in the free condition in the mineral kingdom; both in the gaseous state in mineral springs, and in the liquid condition in small cavities in rocks and minerals. The effervescing springs of Nauheim are said to exhale 1,000,000 lbs. of gas annually. The gas possesses two very important properties, namely, its great weight compared to air, and the power it has of preventing respiration. The great weight of the gas causes it to hang about the lower parts of caves, when exuding from fissures in the rocks, and the case of the celebrated "grotto del cane" in Italy must be well known to many of you; where the gas, lying as it does along the bottom of the cavern, allows a man to walk in the grotto with comparative safety, but at once destroys the respiration of a dog.

The great weight of CO_2 gas is best seen by pouring a jet of it over a lighted candle from some distance. You perceive that the moment I do so, the flame of the candle is at once quenched by a downward invisible stream from the jar. I can also show you its weight by drawing quantities of the gas by this small bucket from the bottom of this long jar, which corresponds to a deep well; you perceive that the taper which originally burned clearly in the bucket, is now extinguished as soon as it is filled with the gas from the well.

Besides the sources already mentioned, carbon dioxide gas is found in a state of combination in several natural products; thus egg-shells contain about 97 per cent. of calcium carbonate; oyster-shells, 98 per cent.; and pearls about two-thirds of their weight of that substance. From such bodies the CO_2 may be derived by treatment with a strong acid, as you see in the jars before you. On adding hydrochloric acid to the shells, a strong effervescence takes place, due to the evolution of the carbon dioxide.

From the presence of this gas in close rooms and unsanitary places it becomes an important matter that we should have ready means for its detection. A common method is the lowering of a candle into deep places, such as wells, where large quantities of the gas sometimes collect, but this method can be but

rarely useful. More accurate methods are to be found in the process of absorption of the gas by caustic potash or baryta, with both of which it readily combines. We have here a graduated tube, termed a Crums tube, and having a small reservoir at the top separated from the main portion of the tube by a stop cock. In this I place some strong caustic potash, and then gently opening the stop cock allow a small quantity to run down the sides of the tube; this combining with the CO_2 in the air causes contraction in the lower part of the tube, the amount of contraction corresponding to the amount of CO_2 gas in the air.

The second oxide, carbonic oxide (CO) is not of so much importance as the carbon dioxide, and is not of so common occurrence in the processes of decay. It is, however, of sufficient importance to warrant our examining its properties very shortly.

The most natural process by which any quantity of the gas may be obtained is by the reduction of the higher oxide CO_2. This can be done most conveniently at a red heat by coke, but also may be effected by certain metals as iron and zinc. If an iron tube be filled with lumps of charcoal and raised to the proper temperature, on passing a current of CO_2 gas through the tube it undergoes reduction, and carbonic oxide is formed—

$$CO_2 + C = 2(CO).$$

An analogous change is seen in the combustion of an ordinary fire. When the whole mass of coal has reached a bright red heat, the CO_2 first produced undergoes reduction as it passes up through the mass, and the monoxide finally burns with a peculiar blue flame on the top of the fire, being converted again into carbon dioxide. Carbon monoxide is an extremely poisonous gas, one volume of it in 100 volumes of air unfitting it to sustain life.

Closely related to carbon dioxide in its chemical composition, we have the substance, carbon disulphide (CS_2), which is produced in small quantities in the destructive distillation of coal, and which may also arise, though unfrequently, in the putrefaction of substances rich in sulphur and carbon.

It is produced by the direct union of sulphur vapour with carbon at a high temperature. It is an extremely volatile liquid, boiling at 118·5° Fahr., and exceedingly inflammable. You will see this on my pouring a few drops of the liquid into this wide beaker, and then warming this glass rod in the flame of a Bunsen burner; on placing the warm rod in the beaker the vapour of the CS_2 at once catches fire, burning with a bright blue flame, and depositing sulphur on the sides of the vessel. When the supply of air is large, full decomposition of the disulphide takes place:—

$$CS_2 + O_6 = CO_2 + 2\ SO_2.$$

Thin iron wire will burn brilliantly in the vapour of carbon disulphide, converting the iron into sulphide. The vapour of this substance acts very injuriously on health, producing poisonous symptoms closely resembling hydric sulphide.

Time will not permit me to place before you the properties of the elementary gases which are sometimes found among the products of decomposition. I have therefore confined myself in my lecture this evening to those substances which may be regarded as the more important of such products.

Next evening we will take into consideration general questions relating to the chemistry of disinfectants, and then proceed to the description of some of the more important chemical substances which are applied to the purpose of disinfection.

Miscellaneous.

SPIDER SILK.

By P. L. Simmonds.

In an article in the *Journal*, which I wrote more than thirty years ago (vol. iii. p. 747), I gave some details as to former endeavours which had been made to utilise the silk of the threads with which spiders form their webs. The subject has cropped up again, in recent attempts of the Paris Society of Acclimatisation to encourage this curious industry. In the last monthly bulletin of that society, it is stated that Monsieur Camboni, a French missionary at Madagascar, has sent home specimens of some large spiders, their cocoons and silky fibre, which he asserts can be utilised for spinning fabrics.

The spiders belong to the family of our common diadem or garden spider, and are named *Epeira Madagascarensis* by Dr. Vinson. He also sends a box of fecund eggs, in order that they may be distributed among the members of the society, with the view of propagating this large spider in the South of France, Algeria, and other suitable localities. As this large spider lives in numerous families on the heights of the province of Imniva, about 4,200 feet above the sea level, and withstands the cold in those

regions, he thinks it might be acclimatised in Europe.

Whether people will be thankful for the introduction of this huge spider remains to be proved, although it may be useful in keeping down the plagues of flies and mosquitoes in certain localities. The well-intended efforts of the acclimatisation societies have not always been beneficial in their results, as the plague of rabbits in Australia, and sparrows in America proves. Still scientific investigations as to the habits and purposes of insects may not be without practical use, therefore I will enter into some details on the subject. The apparatus by means of which a spider forms its silk is a series of glands within the abdomen, near and attached to three exterior parts of the silk-producing organs, called spinnerets. The mode in which spiders form their webs, and the manner in which they throw out cables that are carried by the wind long distances, even across rivers, till they find some attachment, is most curious, and has been much studied by naturalists. Again, many falls or showers of gossamer spider webs have been recorded in different parts of the world.

White describes several in his "History of Selborne." Darwin mentions a similar shower which he observed from the deck of the *Beagle*, off the mouth of the River Plate, when the vessel was sixty miles from land. A general fall of spiders' webs was noticed a few years ago at Milwaukie, and other towns of Wisconsin, which seemed to come from over the lake. The webs were strong in texture, very white, varied from sixty feet in length to mere specks, and were seen as far up in the air as the power of the eye could reach. From the strength of the webs in these showers there would appear to be no doubt as to the spider which produced them. Perhaps the shower may have been due to an unusual excursion of the more familiar geometric spider, this species having the same power of shooting out webs which float upon the air, and sometimes serve as an air-raft for the producer. The natural history of spiders is comparatively an unexplored field of observation; and it is possible that many species emulate the wandering gossamer spider, and betake themselves to the air when occasion serves. From time to time attempts have been made to experiment with spiders' webs, more especially that of the common house spider (*Tagenaria domestica*). Stockings and gloves have in consequence been manufactured from the silken bags within which the female spider deposits its ova. But the difficulty of collecting these egg-bags, and the still greater difficulty of inducing the fiercer little specimens to live together in harmony, soon put a stop to all efforts in that direction. Another difficulty is the want of strength in the fibre.

A French naturalist, Anton Dumarest, states that a material has been obtained by the labour of the common ermine moth (*Hypomomenta cognatilla*), so strong and light as to have been actually worn as a lady's neckerchief. However, the manufacture was more curious than useful, and the experiments have ceased to be carried on. To return to the Madagascar spider, M. Camboni states that there are three species to which attention should be given, the black, the golden, and the large *Epeira*. Its web furnishes the natives with a strong thread used to join their *lambas*, or silk fabrics; and he adds that one of the lateral threads will support a weight of 500 grammes. The long and strong filaments resemble the rich orange or gold coloured raw silk received from China.

If this spider silk is as strong as asserted, it differs materially from some brought to Europe in the 17th century from the tropics, which was greatly admired for its fineness and brilliancy of colour, and made into gloves. Louis XIV. wishing to encourage this new industry, ordered some garments to be made of it, but was disgusted with them the first day he wore them, as they tore in all directions.

Twenty years ago the possibility of utilising the silky fibre of these large spiders was pointed out by Mons. Blanchard, in a conference on silk at Sorbonne. It suffices, he tells us, to take between the fingers the voluminous, ovoid, elongated abdomen of this spider, which always has a thread hanging from one of its glands, and to wind this on a reel or bobbin, for the source seems inexhaustible.

If this spider enjoys a length of years in proportion to its bulk, the quantity of silk produced by the founder of a colony, and its hundred relatives, who are said to live amicably together, must, in the course of time, be considerable. The appearance of these huge spiders would be apt to inspire a feeling of dread in anyone proposing to turn their spinning propensities to advantage. Unlike some of its venomous kindred, however, the creature is represented to be harmless. It was from the threads of this spider that, in the Mauritius, under the administration of General Decaen, the creoles spun a splendid pair of gloves, which were sent to the Empress of the French. It will be a marvellous thing if spider silk, after all that has been written for and against it, should become commercially valuable. In the North-West Provinces of India, spider silk is formed by *Nephilengys malabarensis*, on sticks. *Gasterocantha Madagascarensis* (Vinson) also furnishes a textile material in its silky, green cocoon, which is, however, very small.

ELECTRIC CURRENT METER.

At the recent meeting of the British Association, Professor G. Forbes read a paper describing a new electric current meter he has recently introduced. The instrument the author exhibited might, it was said, be used as an accurare measure for currents from half an ampère or from one ampère upwards. Above the conductor, which consists of a flat spiral of iron wire with two terminals, a set of vanes is pivotted. This consists of a circular disc of mica

with a hole in the centre in which is fixed a pinion with a concentric ruby cup. Round the circumference of the mica disc, eight small cylinders of pith are fixed at equal distances, and eight vanes inclined at 45° to the mica disc are attached to the pith cylinders, these vanes being made of the thinnest mica. This set of vanes is supported by the ruby cup resting on a steel point fixed to the base of the instrument. The pinion engages with the first wheel of a train of clockwork actuating the indexes, which show upon two dials the number of revolutions made by the vanes.

The action of the instrument is as follows. The electric current in passing through the iron conductor creates heat. This sets up a convection current in the air, and this causes the vanes to rotate about the vertical axis and drive the clockwork. The number of revolutions indicated on the dials is, through a considerable range of currents, an exact indication of the number of coulombs or ampère-hours which have passed through the conductor. The friction of the ruby cup on the pivot determines the smallest current which can be accurately measured, and the friction of the clockwork is imperceptible.

APPLE INDUSTRY OF NOVA SCOTIA.

The *Gardeners' Chronicle* quotes from the *Canadian Gazette* some notes of Mr. Justice Weatherbe on the apple industry of Nova Scotia, from which the following particulars are taken. The province consists of as many as 18 counties, and yet the inhabitants of only small parts of three counties —Hants, King's, and Annapolis—are seriously engaged in apple culture. Nearly 21,000 square miles the province contains, but the area of the apple industry may be said to average only 2 to 2½ miles on each side of the track of the Windsor and Annapolis Railway, 80 miles in length, in what we call the Western Valleys; or, again taking the average, which is confirmed by men with a knowledge of surveying, a total area of less than 400 square miles. And of this 400 square miles only 1-30th is planted, and only 1-60th is as yet bearing, though the whole of the 1-30th is rapidly coming into bearing also.

The conditions are exceptionally favourable. Last year it was estimated by the manager of the Windsor and Annapolis Railway, and others well qualified to speak, that 30,000 barrels were produced, yielding about $600,000 (say £120,000). The outlay for maintaining a bearing orchard as compared with the producing power is merely nominal, so that the nett cash yield of an acre, taking the price of apples at $2, would be at least $150 (£30). Many local growers would deem this too low an estimate. One characteristic of this apple-growing belt is the enormous average yield. The Warden of King's County, Mr. Barclay Webster, found on inquiry that a tree produced as many as 26 barrels last year. The average quantity produced is about 75 to 100 barrels of marketable fruit to the acre. In the United States, to judge from the agricultural papers, the experience would seem to be about half that yield. It is, too, a characteristic of the apple growth of these Western Valleys that the trees attain great size and bear fruit to a very great age. While in other places, and in some of the fruit-growing districts of the United States, a tree attains its maturity at from 25 to 30 years, we have in the Western Valleys French trees which must have been planted 200 years ago, and yet they are bearing now. This of itself, it is said with reason, should give our apple growers an advantage over the producers of other countries. And whatever the price may be, they are likely always to obtain a profit.

The apple requires a short period, 6 to 8 weeks, of continuous heat in the season, and a late season in the spring, together with a clay soil, for development under the most favoured circumstances It has these to perfection in the Western Valleys. The soil is magnificent, and the basaltic ridge which runs along the whole length of the valleys protects them from the cool breezes of the Bay of Fundy, which sweep over the other counties.

And yet only 1-30th of the valley is planted. But the fact that double as much is planted as is bearing shows how rapidly the area of growth is tending. Yet the producers are nearly all farmers first and apple growers afterwards. The orchards are generally only from 1 acre to 5 acres. Now, however, the farmers are fast finding out that their orchards bring them the most money. There are many cases in which from $600 to $800 (£120 to £160) have been obtained from one acre in recent years.

The markets are rapidly extending. We are looking to European markets now. Last year about 40,000 barrels were shipped from the rivers running into the Bay of Fundy direct from New York, in consequence of some little temporary difference about the railway rates, thus showing how successfully we can compete with the States growers. They have not the same large crops, while our quality is better.

The industry is a very old one, and has an interesting history. Nearly two hundred years ago a report was made by a Frenchman at Port Royal to the authorities at home in France, in which he spoke of that place as a little Normandy for the production of the apple. Indeed, for from 80 to 100 years prior to the expulsion of the Acadians, in 1755, the industry was carried on, no doubt because it was even then recognised as an exceptionally favoured district. The great settlements of the French in those days were between Port Royal and Grand Pré, and the cultivation of the apple was carried on then, as now, right along these Western Valleys.

This is also the land of "Evangeline," made

famous by the hexameters of Longfellow. After a six days' voyage to Halifax, the English tourist can reach this orchard region in two to three hours by railway. It was, indeed, owing to the investment of English capital in the railway, and the recent improved steamship facilities, that the surprising qualities of the Nova Scotia apples became established in Covent Garden. There is little capital for investment in Nova Scotia, and it remains to be seen whether, after proper inquiry, this narrow fruit belt shall not be entirely occupied and planted by outsiders.

General Notes.

Wild Silkworms.—Mr. Alfred Wailly has undertaken, on behalf of the Société d'Acclimatation, to collect specimens of wild silkworms to be shown in the Paris International Exhibition of 1889. He asks all persons willing to contribute to the formation of a collection of the wild silkworms of the world to communicate with him at Tudor-villa, Norbiton, Surrey. He will be glad to receive specimens of live cocoons, live pupæ, butterflies and moths, &c. Further information can be obtained from Mr. Wailly at the above address.

The Melbourne Exhibition.—The *London Gazette* announces that the Queen has been pleased to nominate as a Royal Commission to represent the arts and industries of this country and its dependencies at the Melbourne Exhibition next year, the Prince of Wales, Lord Rosebery, Lord Hartington, Lord Carnarvon, Lord Onslow, Lord Dunraven, Lord Granville, Lord Kimberley, Lord Brassey, Lord Armstrong, Sir H. Holland, M.P., Mr. E. Stanhope, M.P., Mr. Childers, M.P., Sir John Rose, Sir Reginald Hanson, Sir C. Tennant, Sir F. Leighton, Sir. A. Clarke, Sir Graham Berry, Sir John Gilbert, Sir J. D. Linton, Mr. W. T. T. Dyer, Professor J. R. Seeley, and Mr. William Agnew.

School of Art Wood-carving.—The School of Art Wood-carving at the City and Guilds Institute, Exhibition-road, South Kensington, has re-opened after the usual summer vacation. There are now some vacancies for the Free Studentships maintained by the Institute in the day and evening classes of the school. Forms of application for these free studentships may be obtained from the manager. To bring the benefits of the school more within the reach of the artisan class a remission of half fees for the evening class is made to artisan students connected with the trade. Instruction is also given by correspondence to amateurs unable to attend the school classes. During the past year the students have been engaged on various architectural and other important works. The public are permitted to visit the school and inspect the work in hand on application to the manager, on any week day, except Saturday, between the hours of 11 a.m. and 4 p.m.

Popular Education.—Arrangements have been made in connection with the London Society for the Extension of University Teaching, for several courses of weekly lectures, at Essex-hall, Essex-street, Strand. The subjects include "Astronomy," by E. J. C. Morton, M.A.; "Political Economy," by L. P. Jacks, M.A.; "Electricity in the Service of Man," by W. Lant Carpenter, B.A., B.Sc.; "French Revolution and English Poetry," by the Rev. Stopford A. Brooke, M.A., LL.D. The admission to each lecture is one penny. All the lectures are open to both men and women. There will also be a public lecture by Sir John Lubbock, M.P., F.R.S., on "Ants." Additional information may be obtained from the Secretary to the Committee, Essex-hall, Essex-street, Strand.

German Railways in 1886.—The *Bulletin du Ministère des Travaux Publics* states that the German Railways in 1886 had a total length of 23,145 miles, and of this 20,225 miles belong to the State, while companies' lines worked by the State had a length of 288 miles. These 20,225 miles were distributed as follows among the various States comprising the German Union:—Alsace-Lorraine, 810 miles; Prussia, 13,180; Bavaria, 2,780; Saxony, 1,271; Wurtemburg, 959; Baden, 803; and other States, 422 miles. The capital cost in the same year amounted to £486,120,000, while the rolling stock consisted of 12,450 locomotives, 22,735 passenger carriages, and 250,313 goods carriages. During the year 1885-86, 275 millions of passengers, and 149 million tons of goods were carried. Thus each passenger travelled an average distance of 18 miles, and each ton of goods 66 miles. The gross receipts amounted to £49,720,000, and the working expenses to £28,040,000.

Opium in China.—In the course of a journey through Manchuria, Mr. H. E. M. James, of the Bombay Civil Service, noticed that the opium poppy grows luxuriantly in that part of China, and that the native grown opium had there almost completely ousted the Indian drug. The imports of the latter into Manchuria amounted to £572,000 in the year 1866, but in 1885 to only £31,300. Opium is grown not only for local consumption, but for distribution in parts of northern and central China. The taste for Indian opium is disappearing in favour of the home article, and now that the Che-foo Convention has come into force, and has in fact, though perhaps not in name, imposed an additional duty on the Indian article, it is almost safe to prophesy that in a short time the Indian trade will be seriously affected, and the use of the Indian drug will be confined to a few wealthy *gourmets*. Mr. James further remarks that he can only remember meeting two persons who had ruined themselves in health by smoking opium, and that some experienced foreigners whom he met were of opinion that taken in moderation on a full stomach it is no worse than tobacco.

Journal of the Society of Arts.

No. 1,821. Vol. XXXV.

FRIDAY, OCTOBER 14, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MOTORS FOR ELECTRIC LIGHTING.

The Council of the Society of Arts are prepared to award Four Gold Medals and Four Silver Medals for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which were given in the number of the *Journal* for July 29th.

The competition will take place in London about May or June, 1888. Entries must be sent in by the 31st December, 1887.

Forms of entry can be obtained on application to the Secretary.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.
7. Hand-tooled bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday, 3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered was given in the number of the *Journal* for September 16th last, and can be obtained on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF SUBSTANCES TAKING PART IN PUTREFACTION AND ANTISEPSIS.

By John M. Thomson, F.R.S.E., Sec.C.S.,
Demonstrator of Chemistry, King's College, London.

Lecture III.—Delivered May 16th, 1887.

Having now examined the more important chemical properties of the products of putrefactive decomposition, we come this evening to the consideration of the various substances employed as counteracting agents to such decomposition. The action of these substances is described under the term "disinfection," which may be defined as a process or processes which will avert, counteract, or ultimately destroy products either by physical or chemical means.

At the same time, whilst we may endeavour to give an absolutely strict definition of the term, you will see that this definition can never quite cover, or in itself explain, the very many methods by which the process of disinfection may be carried out. Until within recent years, the term "disinfectants" have been almost universally employed to designate the agents employed in counteracting these putrefactive changes, but lately, and more especially in medicine, the term "Antiseptics" (*anti*, against, and *sepo*, I make rotten) has been introduced, and I have, therefore, in my title taken the liberty of employing the word "Antisepsis" instead of disinfection as the term to indicate the action of these several methods.

Our next duty, after explaining the meaning of the term, is to classify if possible the various methods in which these antiseptic actions may be carried out, and to arrange to a certain extent the various antiseptic agents in groups. This classification may be of a varied nature, but it appears to me that for all useful purposes we may divide the methods by which the actions are produced into the following classes:—

A.—Mechanical and Physical Methods:—
Ventilation; exclusion of air; dryness; extremes of heat or cold; absorption.

B.—Chemical Methods:—
Action of antiputrescent or antiseptic substances.

You will see that any division we make must be purely arbitrary, and that great difficulty will always exist in arranging the methods separately, as certain of the changes mentioned will naturally overlap each other, more especially amongst those of a mechanical and physical nature.

When we examine the substances which act according to these different methods, we find that a further subdivision is necessary, and excluding in this what may be termed purely mechanical actions, such as ventilation, washing, brushing, &c., we may classify the agents as follows:—

Group I.—*Absorbents, deodorisers—*
- *a.* Physical absorbents; dry earth; charcoal.
- *b.* Chemical absorbents; metallic oxides; metallic salts.

Group II.—*Antiseptics, chemical substances—*
- *a.* Inorganic.
- *b.* Organic.

Should it be required, this second group may be again divided into such substances as hinder only temporarily the putrefactive decomposition, and those which absolutely neutralise and destroy the action of the virus.

Exclusion of air is undoubtedly a means of preventing putrefactive changes from commencing, but how long such a state of security may remain is somewhat difficult to fix. Where air is absolutely excluded, or only comes in contact with the material liable to change, in a thoroughly filtered or purified condition, as we saw in the series of flasks in my first lecture, then we may expect no change to take place. The condition of exclusion of air, however, points more to the exclusion of the contagion inducing the change, than to the fact that absolute exhaustion of the air would prevent such a change when once it had been induced. Still, at the same time it retards such changes to a very considerable extent, and a common instance of such a delayed change is to be found in the preservation of logs of wood in peat bogs, where they will lie for great lengths of time in a comparatively unchanged condition, when they are entirely enveloped by moderately dry peat. We may also mention the common household plan adopted for the preservation of eggs, namely, of covering them, when freshly laid, with a film of butter, and then leaving them in some material, such as milk of lime, or fine sawdust, till wanted for use. It must be understood, however, that such methods are purely retarders, and that change will probably take place sooner or later.

Closely allied to this preventive measure we have another condition, the "absence of moisture." Perfect dryness acts as a strong hindrance to decay, as may be seen in the length of time perfectly dry wood will last without undergoing the process of rotting; and there is little doubt that some of the modern methods for the treatment of fæcal matter depend as much on the drying of the material, as they do on mixing it with a porous absorbent. This we shall have to refer to farther on. The influence of moisture in assisting decomposition may be seen on examining two jars of sawdust, one perfectly dry, and the other slightly moistened from time to time. On introducing a lighted taper into the jar containing the damp sawdust, you see that as the taper descends it burns less brilliantly, and when it reaches close above the sawdust, finally goes out. This is due to the production of carbon dioxide gas in the very slow decay of the moist wood.

Extremes of Cold and Heat.

We have seen at the commencement of the course that a certain temperature was necessary to carry on the fermentive change, but at that time I also told you that, should the temperature either rise above or sink below certain limits, such changes become at once arrested. Such is also the case with the changes of putrefaction, which apparently become arrested when the temperature is reduced below the freezing point of water. To show you this, I must content myself with the fermentation of sugar by yeast, which I described to you in my first lecture.

We have here the same flask used on that occasion with a solution of sugar containing yeast in an active state of fermentation. On repeating our former experiment, and transferring some of this to a similar flask containing ice, you observe that the evolution of gas is checked and finally ceases. The practical application of these facts is to be found in the modern method of preserving fish, meat, &c., by cold, so that they may be carried to very great distances. It is to be observed here that this process is most effective when carried out in conjunction with the abstraction of moisture, the material to be kept remaining in a more perfect and better condition for household purposes when preserved in dry air, at a temperature below 0° C, than when kept as the plan originally was, in contact with ice. The presence of moisture, however, if the temperature be sufficiently low, does not prevent the preservation of animal matter for great lengths of time in a more or less perfect condition; and in proof of this I need only remind you of the well-known case of the mammoth found imbedded in a block of ice, in which it had remained preserved for many hundreds of years.

Correspondingly the effect of an extreme in the other direction exercises exactly the same effect, a rise in temperature producing a hindering or cessation of the putrefactive change. We have, as illustrations of such action, the preservation of meat and fruit in closely-fitting tins, the contents of which before closing the tin having been raised to the temperature of boiling water, if not farther. The sterilising, as it is termed, of different materials employed in scientific experiments, is effected by heating them to an extremely high temperature, almost to that of charring, and keeping them for some time at that temperature. In connection with this it is right to mention that for the perfect destruction of certain of the lower organisms which initiate the putrefactive change, it is necessary that the heat be applied more than once, to insure the final destruction of the virus producing the change.

Actual combustion, entailing as it does the final conversion of organic matter into its simplest products, must be regarded as the most effectual method of disinfection, and history shows us that it is one which has been employed from a very early date. The practice of surrounding infected districts with a ring of fires, and thus effectually preventing the contagion from passing, has often been employed in the case of epidemics in highly populated districts, and there is little doubt that the great fire in London was one of the agents most effectual in arresting the spread of the plague in that time.

The well-known methods for the preservation of meat and fruit by enclosing them in tins, and hermetically sealing them when the contents are at the boiling temperature, depend upon the destruction of the exciting cause at that temperature, as well as the exclusion o air from the vessels themselves. That these methods have not been universally successful was found in the case of certain contracts entered into at the time of the Crimean War, when an enormous amount of tinned provisions were supplied to the army in a very advanced state of decomposition.

Processes of Absorption.

Absorption by Charcoal.—Charcoal, from its porosity, may be regarded as one of the most powerful absorbents which we possess, and from this property and the comparative ease with which it can be prepared, is of great value both for the absorption of gaseous as well as liquid products of decomposition.

We shall see that in certain cases the gaseous products not only undergo absorption, but are at the same time decomposed; this is markedly the case in hydric sulphide, but for our present purpose I prefer to regard this absorptive action as of a purely physical nature.

The charcoal employed is generally one of two kinds (*a*) vegetable or (*b*) animal. The first variety may be prepared either by the partial combustion of wood, in the older method by arranging it in heaps covered with turf and sand, or by the more modern method of distilling the wood in closed vessels or retorts, whereby the products of distillation, such as wood tar, water, naphtha, &c., are obtained as well as the porous charcoal. Animal charcoal is obtained by the partial combustion of bones, and differs from wood charcoal in containing a much larger quantity of mineral matter, apparently making it much more valuable as an absorptive medium.

The porosity of charcoal can be readily demonstrated to you by placing a piece of wood charcoal, weighted with lead, in this cylinder, which is filled with tap water, and arranging it under a bell jar in the air-pump. On giving a few strokes to the pump you perceive little bubbles forming on the surface of the charcoal, these gradually increasing in number till, as the exhaustion proceeds, the tap water begins to effervesce like soda water

from the escape of the bubbles of air originally contained in the pores of the charcoal.

Another striking illustration of its capability to absorb gases may be seen on allowing some small pieces of recently calcined charcoal to pass up into dry ammonia gas in a tube standing over mercury. You perceive that the moment I introduce the piece of charcoal into the tube, absorption at once begins, the charcoal absorbing a volume of gas very much larger than its own volume. On removing the charcoal from the mercury, the ammonia gas will escape from it again very readily, and its presence can be easily perceived by its odour.

The absorption of gases by charcoal varies according to the nature of the material from which it is prepared, a dense variety of wood like boxwood or cocoanut generally yielding the most absorptive variety of charcoal. This absorption has been examined by Saussure, Angus Smith, and Hunter, and the following Table shows you roughly the coefficients of absorption for certain gases.

Absorption of Gases by Charcoal.

One volume of charcoal absorbs—

90	vols. of	ammonia gas.
85	,,	hydrochloric acid gas.
65	,,	sulphur dioxide gas.
55	,,	hydric sulphide gas.
40	,,	nitrous oxide gas.
35	,,	carbon dioxide gas.
9·4	,,	carbon monoxide gas.
9·2	,,	oxygen gas.
6·5	,,	nitrogen gas.
1·25	,,	hydrogen gas.

The general point to be observed in examining such absorption is the fact that, the more readily the gas undergoes liquefaction, so does its absorption by the charcoal increase, pointing to a partial condensation of the gases in the pores of the charcoal; such gases as oxygen, hydrogen, and nitrogen, which are liquefied only with difficulty, having a very small coefficient of absorption.

As I mentioned to you at an earlier period of my lectures, some gases are not only absorbed by the charcoal, but appear also to undergo a certain amount of decomposition from the air already held in its pores. This is to be seen very markedly with gases such as hydric sulphide, or with those derived from the putrefaction of material rich in nitrogen. In the former case the gas becomes converted into H_2O and SO_2 in a manner analogous to its decomposition during incomplete combustion. After some time the sulphur dioxide undergoes oxidation in the presence of moisture, resulting in the formation of sulphuric acid (H_2SO_4). Free sulphur can also be extracted from the charcoal by proper solvents at a certain stage of the absorption. In the case of ammonia this gas apparently becomes gradually converted into ammonium nitrite and nitrate.

Boxes containing charcoal in a suitable state of division have been used for the filtration of noxious gases from drains; and respirators of the same nature have been introduced for wearing over the nose and mouth. Those of you wishing to test the efficiency of charcoal as an absorbent of disagreeable odours, may do so by examining this jar which I have on the lecture table. It contains a piece of animal matter in an advanced stage of decomposition, which is covered with a layer of charcoal about three inches in depth, and you will perceive on smelling above the charcoal that no offensive odour can be detected; on removing the little plug, however, in the lower part of the chamber, you will at once detect the putrid odour.

Recently calcined charcoal may be most advantageously employed when thickly strewn over decaying matter; placed in trays as a ventilator in air passages, or employed for the packing of fish, game, or meat, for transmission from one place to another.

Charcoal may be employed for the absorption of liquid and solid substances as well as gases, and the colour of logwood and indigo may be readily removed from solutions of these substances by shaking them with wood or animal charcoal. The decolourising power of wood charcoal is much inferior to that of bone charcoal; which is attributed to the circumstance that the latter, when examined, is found to contain much less carbon than the former, but a considerable quantity of mineral salts, as calcium, phosphate, &c., the presence of which separates the particles of carbon over a much larger area, and so presents a much larger surface for the absorption of the colouring matters. Animal charcoal is employed in sugar refining for the decolourisation of the brown syrup before its evaporation to obtain the white crystallised sugar.

The employment of charcoal as an absorbent for noxious gases and other kinds of filtration, was first prominently brought forward in this country by the late Dr. Stenhouse, Mr. Turnbull, and Dr. Angus Smith.

In certain cases, materials other than char-

coal may be employed as absorbents, and the methods for the treatment of excreta, originally devised by Mr. Moule, depend upon the employment of dry powders or earth. For the proper carrying out of the process of disinfection with such bodies, certain rules must be observed, the neglect of which diminishes to a great extent the value of the method. In the case of dry powders or earth, these must be brought in contact with the material as soon as possible, must be intimately mixed with it, and must be in a perfectly dry condition, so as fully to carry out their absorbing action.

Chemical absorbents.—Another class of substances which we may regard as acting as absorbents are mineral substances such as quicklime (CaO) and certain metallic salts, most notably lead acetate [$Pb(C_2H_3O_2)_2$], bismuth nitrate [$Bi(NO_3)_3$], zinc chloride ($Zn\,Cl_2$), and ferrous sulphate ($Fe\,SO_4$).

These substances evidently act by absorbing the noxious gases forming with them, compounds which fix the gas and remove it from the surrounding air. Quicklime readily absorbs the carbon dioxide, becoming converted into carbonate, and lead acetate, or bismuth nitrate will absorb the hydric sulphide, forming sulphides; whilst ferrous sulphate may be employed as an absorbent for such gases as ammonia or nitric oxide. Such substances are of especial value as absorbents in sick rooms, &c.

The researches of Dr. Frankland have shown that in the case of iron salts they apparently exercise a specially destructive action on bacteria.

Properties of Certain Inorganic Disinfectants.

In examining the disinfecting substances belonging to or derived from inorganic sources, I will endeavour to arrange them as much as possible in the following order; but I wish it to be understood that no strict chemical classification or grouping of these substances, can be at all well made.

a. Certain gaseous substances and the bodies from which they are derived, as—

Chlorine, bromine.
Hypochlorites.
Oxygen, ozone, hydrogen peroxide.
Potassium permanganate.
Sulphurous acid gas.

b. Strong mineral acids, sulphuric acid.
Fumigations by nitrous and nitric acids.
Boracic acid, borax.
Arsenious acid.

c. Certain metallic salts.
Chlorides of zinc, aluminium and iron.
Sulphates of zinc, iron and copper.

Such antiputrescent substances probably exert their influence in the following different ways :—

1. They may abstract water from the fermentable substances, and so exercise a drying or mummifying action.

2. They may form compounds which are less liable to undergo decomposition.

3. They may decompose the ferment producing the change.

4. They may deoxidise the ferment; or remove the oxygen from the surrounding air.

5. They may kill the fungi, or the germs, exciting the putrefactive change.

Certain of the antiseptic substances may carry out their action according to one of these methods only, whilst others may act according to two or more of the methods specified.

Chlorine gas has been long employed as a disinfectant, having been first introduced by Guyton de Morveau about one hundred years ago. This element, with its associates, bromine and iodine, are extremely active agents, both in combining with other elementary substances and in decomposing certain organic compounds to which as we have seen many of these putrefactive substances belong. They are all obtained more or less directly from sea water, where they exist as chlorides, bromides, or iodides of certain metals; from which they may be obtained by the action of sulphuric acid in presence of binoxide of manganese.

You will readily perceive the energy with which chlorine acts upon other substances if I bring some finely powdered antimony in contact with the gas, which I do under this bell-jar, when you see the antimony catching fire and burning, as its powder falls into the bottle of chlorine gas. Almost all the metals unite in the same way, if in a finely divided condition, forming chlorides, and this property must be kept in mind during the disinfection of a room by chlorine gas, when all metal articles must be removed or covered up.

It unites directly in the cold with phosphorus, as you will perceive on my taking a small piece of that substance in this deflagrating spoon, and plunging it into a bottle of chlorine. The phosphorus at once catches fire, forming thick fumes of phosphorus chloride.

Chlorine gas unites directly with many

non-metallic elements, more especially with hydrogen, and it is upon this tendency to combine with that element that the chief applications of chlorine depend. The two gases will unite directly when brought together in daylight; but they may also be made to combine when chlorine is brought in contact with an organic body rich in hydrogen.

You will recollect that I showed you in a former lecture the decomposition of olefiant gas ($C_2 H_4$) by chlorine, and a similar decomposition may be seen if we employ another hydrocarbon turpentine ($C_{10} H_{16}$) still richer in hydrogen. On smearing a little spirit of turpentine on filter paper, and introducing it into a bottle of the gas, energetic action takes place, with an enormous deposit of free carbon.

This energetic action of chlorine causes it to unite with the hydrogen in water, liberating oxygen, and it is to this property of acting as an indirect oxidising agent that its bleaching and disinfecting properties are attributed. Many vegetable colouring matters of great permanency, such as indigo, undergo an oxidising action in the presence of moist chlorine, the indigo being first oxidised into isatin, and then by excess of chlorine converted into chlorisatin.

$$\underset{\text{Indigo.}}{C_8 H_5 NO} + H_2 O + Cl_2 = \underset{\text{Isatin.}}{C_8 H_5 NO_2} + 2 HCl.$$

$$C_8 H_5 NO_2 + Cl_2 = \underset{\text{Chlorisation.}}{C_8 H_4 Cl NO_2} + H Cl.$$

From this you will perceive that the chlorine must be in the presence of moisture to effect the action; the indigo being oxidised to isatin at the expense of the oxygen in the water. In fact, dry chlorine will not bleach, as is shown us in this vessel, where some crimson paper is suspended in a jar of the dry gas, remaining in it quite unchanged.

For the purposes of disinfection, either free chlorine or its solution in water is somewhat inconvenient, and it has become the custom to employ for this purpose a substance known to you as "bleaching powder;" most probably a mixture of calcium hypochlorite with calcium oxychloride [$Ca (Cl O)_2 + Ca_3 O_2 Cl_2$]. This powder, or its solution, on treatment with dilute acids, liberates chlorine gas in a manner more suitable for practical purposes. The solution of the powder itself does not bleach litmus, as you see on adding it to this jar, but a few drops of dilute sulphuric acid at once causes the disappearance of the colour, owing to the liberation of chlorine. Such gases as hydric sulphide, ammonia, and substances similarly constituted, are at once broken up by chlorine gas.

The properties of bromine and of iodine vapour appear to act in a manner similar to chlorine, but in the case of iodine the action is somewhat weaker. Both these elements impart very distinct colours to certain solvents which readily dissolve them. Thus on shaking an aqueous solution of bromine with ether, we obtain a brilliant yellow colour in the ethereal layer, whilst iodine may be extracted from its solution by carbon disulphide, which, being heavier than water, sinks to the bottom coloured a deep purple by the absorbed iodine.

Bromine must evidently be regarded as a stronger agent than iodine, and apparently in its disinfecting action stands intermediate between chlorine and iodine, just as it does in its ordinary chemical relations to these substances. Of late it has been introduced in a convenient form for deodorising and disinfecting as "Bromodine," a mixture of a bromide and bromate, of which I have a small quantity in this jar. This mixture in a perfectly dry state, is mixed with potassium bisulphate also in the same condition; as long as these powders remain perfectly dry they may be kept together unchanged, but on moistening the mixture with water, action at once commences with the evolution of bromine.

For the disinfection of an ordinary room by these agents, the room should be cleared if possible of all metallic articles, those which cannot be removed being covered to as great extent as possible. The chlorine may be evolved by treating a mixture of common salt and manganese binoxide with sulphuric acid. The room should be thoroughly closed and kept in this condition for some time. After sufficient time has elapsed for the chlorine to permeate thoroughly through the whole space, the room may be opened and ventilated with a current of fresh air.*

Oxygen, Ozone.—The next gaseous disinfectant I would bring before your notice is oxygen gas, and its condensed modification ozone. There is no doubt that oxygen must be regarded as the great natural purifier, and that a proper state of sanita-

* Since the above was written Mr. W. Thompson, at the meeting of the British Association at Manchester, has proposed the employment of certain compounds of fluorine as antiseptic and preservative agents, and has described the very satisfactory results obtained by the use of these substances.

tion depends almost entirely on a large and pure supply of pure air. It occupies a peculiar position in the processes of putrefaction; a certain amount being necessary for the production or continuance of the changes, but an excess counteracting and destroying the action. Its anti-putrescent action is evidently that of increasing the vital energy of the different growths to such an extent that they become destroyed by rapid oxidation. In the case of such substances as hydric sulphide, we have seen how this oxidation taking place in the pores of the charcoal finally lead to decomposition.

Ozone (O_3) and Hydrogen Peroxide (H_2O_2).—As the supply of oxygen in the free condition must of necessity be very large to perform a thorough disinfecting action, we are induced to look for such agents as will supply us with that substance in a condensed and active condition. These are to be found in the two substances, ozone and hydrogen peroxide, the former of which may be regarded as oxygen in a modified and concentrated form. Ozone exists free in the atmosphere, especially near the sea or in the open country, and possesses a peculiar odour from which it receives its name. It is formed by the silent discharge of electricity, by the electrolytic decomposition of water, and by the slow oxidation of such easily oxidised substances as ether and phosphorus.

Its properties are like those of oxygen, only in a much more energetic form; and it is from the energy with which it unites with potassium when combined with iodine, that we are enabled to test for it and show its presence.

I have here what is termed a Siemens ozonising apparatus, by means of which, on attaching the tinfoil with which it is coated to a Ruhmkorff coil, and passing through the apparatus a current of dry oxygen, you will presently perceive a very distinct odour of ozone. That the oxygen has undergone change we can readily see by bringing in front of the apparatus some white paper, on which I have written with a mixture of starch paste and potassium iodide. The energy of the combination between the potassium and the ozone liberates the iodine from the compound, and this at once gives with the starch the characteristic blue colour. In this change we find that the oxygen has undergone condensation, and that a contraction of $\frac{1}{12}$ in the volume of the oxygen has taken place; the ozone, however, is never obtained in its production, unmixed with oxygen.

Its production by the slow oxidation of phosphorus in the presence of water you see going on before you in these bottles, in which we have some half immersed sticks of phosphorus. On bringing some iodised starch-paper into the mouth of the bottle you at once see the liberation of the iodine by the ozone.

From the presence of ozone in ordinary air, and from the activity of its properties, it is natural that it should have attracted attention as a possible natural disinfectant; and this supposition is strengthened by the fact that none is found in crowded places, where there are many reducing agents capable of using it up, and that when such do not exist, as in open country, ozone is apparently always present. The quantity, however, in which it is found is very minute, and has been approximately fixed by M. Honzeau at $\frac{1}{700000}$ of the volume of air. It is in larger quantities in summer than in winter. A small amount of evidence has been brought forward of the production of ozone in the oxygen which is given off by plants, but it is somewhat conflicting; it is found, however, in the evaporation of certain essential oils, and the following are extracts from experiments conducted on this point by Dr. Angus Smith.

Comparative quantities of Ozone given off from certain essences.

	After 48 hours.	After 72 hours.
Essential oil of orange	9	10
Essence of terebenthine	7	9
,, cumin	2	2
Cresylic acid	2	2

The determinations were made with standard iodised papers.

Hydrogen peroxide is not of so great importance, but is somewhat allied to ozone in its oxidising properties. It has sometimes received the name of "oxygenated water." When this substance is brought in contact with decomposing matter the putrefactive odour disappears, and ozone, or ozonised oxygen, is liberated. Its power, however, rapidly diminishes with the loss of ozone.

The properties of hydrogen peroxide are very interesting from a chemical point of view. It undergoes decomposition when brought in contact with certain metals, such as gold, silver, and platinum, which have no direct attraction for oxygen, and certain oxides also effect its decomposition without themselves undergoing change. The oxidising power of

hydrogen peroxide may be readily seen by bringing it in contact with chromic acid. On mixing together a very dilute solution of potassium bichromate with a little dilute sulphuric acid, and adding a drop or two of hydrogen peroxide, a beautiful blue colour, due to the formation of perchromic acid, is produced. If the solution be now shaken with ether, the blue colour is extracted and made more permanent, permitting us to detect by this means very small quantities of hydrogen peroxide.

Dr. Angus Smith, in 1869, proposed this substance as a disinfecting agent, but its expense at that time prevented its employment in practice.

In the changes of hydrogen peroxide I have shown you that that substance alone has undergone decomposition; but if we bring it in contact with potassium permanganate ($K_2 Mu_2 O_8$), itself a substance rich in oxygen, both undergo decomposition, large quantities of oxygen being given off. This is seen when I add a few drops of dilute $H_2 O_2$ to this solution of the permanganate acidified with sulphuric acid, when the red colour of the permanganate is at once destroyed, and bubbles of oxygen gas are given off, which re-ignite a spill plunged into the gas.

Potassium Permanganate—Condy's Fluid.—The efficacy of this substance depends upon the facility with which it parts with its oxygen, and the amount and purity of the gas which is obtained from it. Many organic substances are oxidised by it, more especially those arising from putrescent changes.

The ease with which organic matter may be oxidised is readily shown you by taking a sample of impure water, such as I have here, and adding to that some dilute Condy's fluid acidified with sulphuric acid. The colour at once disappears, showing the reduction of the permanganate. As the potassium permanganate in its reduction loses a definite quantity of oxygen if a standard quantity be used in the experiment, then the quantity of oxygen lost is known, and from this the quantity of organic matter oxidised may be approximately calculated The oxidising power of this substancc is very well shown in its action on glycerine, which when brought in contact with solid permanganate, undergoes direct combustion, burning at the expense of the oxygen derived from the permanganate. Oxygen may also be obtained from it directly by heating, and you perceive that an incandescent spill of wood is at once rekindled by the oxygen derived from heating the permanganate I have in this tube.

The preparation of potassium permanganate can be best shown to you by heating caustic potash (K H O) and manganese dioxide together in a silver dish. By this means potassium manganate, a green substance, is formed, but on pouring this into a large volume of water, and adding to it an acid like nitric acid, we have the green colour changed at once to the brilliant crimson of the permanganate. The green fluid of Condy is the sodium manganate ($Na_2 Mu O_4$).

Sulphur Dioxide, or Sulphurous Acid Gas (SO_2).—This substance has been known and employed as a disinfectant for a very great length of time, both from the strong antiseptic properties which it possesses, and the ease with which large volumes of the gas may be obtained. The method for its preparation most suitable for the purposes of disinfection is by the combustion of elementary sulphur in a suitable supply of air or oxygen; or by the combustion of some substance rich in sulphur, such as we have in carbon disulphide (CS_2).

Sulphur dioxide, like chlorine, possesses strong bleaching properties, but, unlike that gas, it acts by abstracting oxygen from the material with which it is brought into contact; that is, it acts by reduction. Its bleaching properties may be seen by burning some flour of sulphur under a bell-jar in which a bunch of violets has been suspended, when you see that the colour of the flowers very rapidly undergoes a bleaching action, ultimately becoming perfectly white. Its action is, however, in this case, somewhat weak, as the colour may be recovered by washing the flowers in a weak solution of ammonia, when the hues of the flowers are restored, but not in their original beauty.

The antiseptic action of sulphurous acid is best seen by pouring a little of the solution of the gas, in water, into a flask with fermenting sugar, when the evolution of the CO_2 very soon ceases. Certain of its salts or sulphites are also employed for this purpose. The gas is also used for the fumigation of clothes and rooms, to kill vegetable and animal growth, and this antiseptic property is valuable for the sulphurising of wine and beer casks, to prevent any growth of a ferment likely to destroy the fresh liquor.

In its antiseptic action, sulphur dioxide evidently acts as a reducing agent, depriving the surrounding material of oxygen and

becoming converted into sulphuric acid. This oxidation is readily seen when we pass a current of dry oxygen gas mixed with sulphur dioxide over some heated platinised asbestos, when you perceive that the transparent gases are converted into dense white fumes. In this action we have the direct conversion of SO_2 into SO_3 by the addition of an atom of oxygen. This process is now carried out on the large scale for the production of the solid sulphur trioxide. A somewhat peculiar action is observed when gaseous SO_2 is brought in contact with H_2S gas, in which apparently both undergo decomposition with the formation of water and sulphur. The reaction is probably not so simple as this in reality, some of the higher or thionic acids being formed at the same time.

The well-known disinfecting powder termed "MacDougall's disinfectant" is composed of a mixture of calcium sulphite with carbolic acid, a substance which we shall have to examine later on. Another variety is a mixture of sodium sulphite with calcium carbolate.

Sulphurous acid and the gas form an extremely good disinfecting agent for domestic purposes, in certain instances more convenient to employ than chlorine, the manufacture of which in an ordinary room is attended with a certain amount of inconvenience. With SO_2, on the other hand, which can be produced in large volumes by simply placing some flour of sulphur in an iron vessel and igniting it with a red-hot coal, the sulphur burns perfectly quietly, and no farther heat need be applied.

Sulphuric Acid (H_2 SO_4.)— This substance is produced, as we have seen, by the oxidation of sulphur dioxide, and may be regarded as one of the strongest of the destructive agents. It acts most distinctly as a germicide, possessing, like the other mineral acids, hydrochloric and nitric acids, a most corrosive action on the material coming in contact with it.

From this property of acting so strongly on organic substances, the concentrated acid has been employed on a large scale for the protection of wooden stakes intended to be fixed in the ground or under water. This protection is produced through a partial charring of the wood by the acid, as I can show you with this vessel containing some wood shavings. On pouring the sulphuric acid on the shavings, they at once become coated with a protecting layer of inert carbon, which protects them from all ordinary action.

When brought in contact with certain carbonaceous substances, which contain also hydrogen and oxygen in the proportions in which they exist in water, such as sugar (C_{12} H_{22} O_4) and wood fibre (C_6 H_{10} O_5) it exercises a dehydrating action, leaving the carbon in its elementary condition. This is most markedly seen on pouring some of the strong acid on some thick syrup of sugar, when the whole mass undergoes charring, frothing up and evolving clouds of steam.

The sulphuric acid not only chars the surface of the wood, but apparently exerts some action on the tissue in the interior in a manner similar to that seen in the formation of parchment paper. Its solvent action on pure cellulose is also very marked, as may be seen on adding some pure cotton to the concentrated acid, when you perceive that it gradually passes into solution. The corrosive action is seen very markedly in the clearing up of coagulated albumen, of which I have some in this glass beaker. On adding the sulphuric acid, even in a very dilute condition, the liquid becomes perfectly clear, the albumen having been entirely decomposed. The antiputrescent characters of this acid, as well as of hydrochloric and nitric acids, have been examined, more especially by Dr. J. Dougall and the late Professor Baxter. Alkaline or neutral liquids left to themselves become charged with mycelium and bacteria, and frequently acquire a fetid odour. If, however, another portion of the fresh liquid be treated with acid in sufficient quantity to render it distinctly acid, the fermentation is slow and without the production of bacteria; should the acid be in very distinct quantities, all growth is stopped, and no putrid odour is produced.

Obituary.

JAMES GRIERSON. — Mr. Grierson, General Manager of the Great Western Railway, died, in the 60th year of his age, at Great Marlow, on Friday, 7th inst., after a short but severe illness. He entered upon his office of manager about 20 years ago, and during his management most of the important changes and improvements which have raised the Great Western Railway to its present position, and rendered it a profitable property to its shareholders, have been carried out. Among these were the abandonment of the broad gauge

over a portion of the line, and the working of most of the traffic upon the narrow gauge system, the re-building of Paddington Terminus and many other stations, the construction of the Severn Tunnel, and the adoption of the electric light between Paddington and Westbourne-park. Mr. Grierson attended the congress of railway officers at Milan, and was taken ill immediatelv after his return from Italy. He became a member of the Society of Arts in 1873, and was elected on the Council at the anniversary meeting in June last.

CHARLES MOSELEY.—Mr. Moseley, the eminent merchant of Manchester, died in that city, on Saturday, 1st inst., aged 48 years. He had been associated with the firm of D. Moseley and Sons from boyhood, but it was not until some eight or nine years ago that his interest in the telephone induced him to step forward into public life. He at one time contemplated establishing a private telephonic exchange in Manchester, but after the amalgamation of the Edison and Bell companies he became chairman of the Lancashire and Cheshire Company. As a result of his endeavours, the present "trunk line" system has been developed, by which it is possible for most of the Lancashire towns to hold telephonic communication with each other. When the Edison Electric Light Company was formed, his interest in electricity induced him to take a leading position as a director. He was also one of those who consented to form a consultative committee to consider and report upon the merits of the scheme for the Manchester Ship Canal, with the result that he and his colleagues on the committee were converted by the evidence which was laid before them to a full belief in its value. He subsequently took a leading part in arranging for the Manchester Jubilee Exhibition. Mr. Moseley was elected a member of the Society of Arts in 1884.

General Notes.

KING'S COLLEGE, LONDON.—In the Department of Evening Classes during the Winter Session, 1887-8, a course of about eighteen lectures will be delivered on "Agriculture," by Mr. F. J. Lloyd, F.C.S., F.I.C., on Fridays, beginning October 14, the subjects being Soils, Manures, Crops, and Live Stock. The lectures will be especially adapted to prepare students for the examinations of the Royal Agricultural Society, and of the Surveyors' Institute.

MEMORIAL TO THE LATE ADMIRAL SIR C. F. SHADWELL, K.C.B.—A committee has been formed with the object of establishing a memorial of the late Admiral Sir C. F. Shadwell, K.C.B. It is proposed that the memorial should consist of an annual prize to be offered for the most useful marine survey, carried out and projected by an officer of not higher rank than lieutenant in H.M. Navy, while employed in general service. The chairman of the committee is Admiral Sir Alfred Ryder, and the hon. secretary is the Rev. J. B. Harbord, Chaplain of the Fleet.

WELLS IN TUNIS.—A communication is referred to in the *Bulletin de la Céramique* as having been recently made by M. de Lesseps to the French Academy of Sciences, with regard to the works now progressing in Tunis, on the coast of the Gulf of Gabes. Commandant Landas, having recently ascertained the existence of underground water in this region, thought it could be employed in fertilising the locality, and thus attracting a population whose labour would be of material assistance in digging the canal which would supply the projected internal sea. The investigations and soundings have so far been successful, one well having been found yielding 1,800 gallons of water per minute, and another 2,000 gallons per minute.

TIMBER TRADE OF FINLAND.—A writer in a recent number of the *Russische Revue* of St. Petersburg states that 56 per cent. of the total area of Finland is either forest or marsh covered with forests. Approximately, half of this belongs to the Crown, and half to private owners. For some years past the export has remained stationary at about 50 millions Finnish cubic feet, but in 1885 it decreased to 41 millions, and in 1886 it was about 20 per cent. less. Hence much less timber has lately been felled, and to this circumstance those interested in the trade look for an increase in the price of timber. The export to all the British ports, such as London, Liverpool, Grimsby, Hull, Hartlepool, &c., was very much reduced. Apart from the general depression of trade, this decrease is attributed to a decreased demand for timber, the increase of freight, and the want of shipping in the ports of Finland.

HOP APHIS.—Professor C. V. Riley, in a paper read before the British Association at Manchester, stated that the hop aphis (*Phorodon humuli*) spends a part of its cycle of existence on the plum or other species of *Prunus*. The insect produces winged females about the middle of August, which deposit their young on the plum, and these produce male winged and female wingless insects, the latter depositing eggs on the bark of the twigs (usually on the previous year's growth). These eggs are not easily seen, being laid singly and covered with particles resembling the bark in colour and appearance. They are also very small, being only 0·04 mm. long. These insects become hatched early in spring, and after three generations become winged, the winged generation migrating to the hop in April. Frost and extreme heat and drought are fatal to the insect. It is recommended by Professor Riley that plum trees should not be grown near hop gardens, and that the wild plum trees in their neighbourhood should be destroyed, so as to prevent propagation of the insect during the winter. The aphis can be destroyed on the hop by syringing with soft soap solution.

Journal of the Society of Arts.

No. 1,822. Vol. XXXV.

FRIDAY, OCTOBER 21, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

The fund collected amongst members of the Society of Arts for the Imperial Institute has now been closed. The total amount contributed by members of the Society amounts to £2,310 5s. 6d.* This amount has been handed over to Sir Frederick Abel, the Organising Secretary of the Institute. The amount expended for printing, postage, and stationery in connection with the collection of the fund is £39 3s. 9d., and this has been refunded by the Institute. The Secretary has received the following letter from Sir Frederick Abel, together with the memorandum which is appended:—

"Imperial Institute,
"1, Adam-street, Adelphi, London,
"14th Oct., 1887.

"Dear Sir,—I beg to acknowledge the receipt of your letter of the 13th instant, enclosing cheque, value £310 15s. 6d., being the balance of the subscriptions collected by the Society of Arts on behalf of the Imperial Institute, and making, with previous remittances, a total of £2,310 5s. 6d.

"I have had much pleasure in submitting your letter to the Prince of Wales, and I have been instructed by his Royal Highness to request that his cordial thanks may be conveyed to the donors of your Society's fund.

"I have given directions for a cheque, representing the value of the charges to which you have been put in collecting the subscriptions, to be prepared, and the same shall be forwarded to you in due course.

"I also have the pleasure, by direction of his Royal Highness, to enclose a memorandum descriptive of the progress which has been made, to date, in the establishment of the Imperial Institute, as the Prince believes that the information which it contains will be of interest to members of the Society of Arts.

"The very satisfactory progress which has been made during the first nine months of organised work towards ensuring the foundation of the Institute upon such a basis as to allow of the extension of its sphere of usefulness in all the contemplated directions, warrants the sanguine expectation that the amount which has been estimated as necessary for that purpose will be provided within no very distant period.

"A considerable number of Committees have signified their willingness to prolong their operations, with the especial object of obtaining additions to the 'Endowment Fund' of the Institute, which is about to be created. His Royal Highness trusts that it may be possible for your Society to adopt this course.

"I have the honour to be,
"Dear sir,
"Your obedient servant,
"F. A. Abel,
"*Organising Secretary.*

"H. Trueman Wood, Esq.,
"*Secretary, Society of Arts,*
"John-street, Adelphi, W.C."

Memorandum for the Information of Subscribers.

The financial prospects of the Institute have made very satisfactory progress since the proposal for its establishment was brought to the notice of the public by the meetings held at St. James's-palace and the Mansion-house in January last.

The funds received and definitely promised, at this date, for the foundation and maintenance of the Institute, amount to over £400,000. This sum is represented by the following contributions, stated approximately—From different parts of the United Kingdom, £220,000; from the colonies, £80,000 and from the Indian Empire, £100,000.

More than two-thirds of the full value of the subscriptions notified have been received and invested.

Returns have as yet been received from some of the Colonies only. In reference to the contributions which are being received from this source, it is especially interesting to note that many of the smaller of her Majesty's possessions (*e.g.*, the Island of Ascension and the Bechuanaland and Fingoe Territories) have, by the amount of their offerings, and by the manner in which these are subscribed, furnished valuable testimony of the active interest taken by the inhabitants of those distant countries in the establishment of an institution designed to bring all parts of her empire into intimate touch with each other.

From the larger Colonies information is received from time to time that practical proof is being furnished of the sympathy of the inhabitants with the welfare of this undertaking. As illustrating this, it

* Since the last announcement in the *Journal*, giving a total of £2,308 3s. 6d., a subscription of two guineas has been received from Mr. W. H. Penning.

may be stated that the contribution of £2,853 4s. 4d. has been received from New Zealand, which is composed of subscriptions made by inhabitants of the Colony, and is entirely distinct from the grant proposed to be made by the New Zealand Government.

In the Indian Empire, contributions from native princes and through local committees there formed, continue to be received, and the anticipations respecting the prominent part which India would take in the establishment of the Institute are being fully realised.

In the United Kingdom many of the committees which were formed last spring in various counties, cities, and boroughs, burghs, and townships, are still continuing, and with success, to apply their organisation to the increase of the funds of the Institute.

His Royal Highness, the President of the Institute, has considered it desirable to enlarge the Organising Committee from time to time, by the additional appointment of several eminent men who have evinced readiness to afford active support to the undertaking, and to give their gratuitous services in aid of developing the scheme of government, and the sphere of action of the Institute.

The constitution of the representative governing body which his Royal Highness the Prince of Wales desires to see at the head of the Institute, has already received careful consideration on the part of the Organising Committee. A preliminary outline of the probable mode of its construction was published some time since, with the object of inviting suggestions from public or official sources. Several have already been received; they will be carefully considered when, at the termination of the recess, the committee devote their attention to the completion of this part of their task.

Preliminary steps are being taken in view of obtaining at an early date a Royal Charter of Incorporation for the Institute.

His Royal Highness has appointed the Lord Herschell, the Earl of Rosebery, and Sir John Rose, Bart., trustees to the Imperial Institute, and arrangements are being made to invest in the names of these trustees, and in a suitable manner, a proportion of the funds subscribed, to form the nucleus of an "Endowment Fund," to which it is confidently expected that important additions will be received from private sources.

The Royal Commission of the Great Exhibition of 1851 having made to the Imperial Institute a grant of land at South Kensington, consisting of about six acres, with the possibility of additions thereto, should the work of the Institute demand increased accommodation, the foundation stone of the building designed by T. Collcutt, Esq., F.R.I.B.A., was laid by her Majesty the Queen on the 4th of July last. Her Majesty's subsequent donation of £1,000 to the funds of the Institute affords an additional and most gratifying testimony of the interest taken by the Queen in the success of an undertaking designed by his Royal Highness the founder of the Institute to accomplish the great work—initiated by the illustrious Prince Consort—of cementing the bonds of intimate relationship and co-operation between every class of her Majesty's subjects, through their devotion to the establishment and maintenance of unity of operation between all branches of manufactures, commerce, and education, and between all cultivators of science and the arts. The brilliant success of the ceremonial which, on the 4th of July, was witnessed by a concourse of over 10,000, afforded an interesting record of public sympathy with the foundation of this national memorial of her Majesty's Jubilee.

The first steps towards the erection of the main buildings of the Institute have been taken; a contract has been entered into for the construction of its foundations, and the work will be commenced forthwith. The details of construction of the new road, which will connect Queen's-gate and Exhibition-road along the frontage of the Imperial Institute, are in course of settlement.

As some considerable time must elapse before the Institute buildings can be occupied, it is under consideration to commence as soon as practicable, and to gradually develop, certain important branches of the work of the Institute which may be conducted in temporary offices, such as the organisation of an intelligence department in connection with the Colonies and India, bearing special reference to commerce and emigration.

F. A. Abel,
Organising Secretary.

1, Adam-street, Adelphi, London, W.C.,
October, 1887.

Proceedings of the Society.

CANTOR LECTURES.

THE CHEMISTRY OF SUBSTANCES TAKING PART IN PUTREFACTION AND ANTISEPSIS.

By John M. Thomson, F.R.S.E., Sec.C.S.,
Demonstrator of Chemistry, King's College, London.

Lecture IV.—Delivered May 23rd, 1887.

As time did not permit of my entering in my last lecture into the consideration of some of the more important disinfecting agents belonging to the inorganic division, I must proceed this evening to the description of the properties of some of the remaining substances in that division; and finally to the consideration of certain substances derived from organic sources.

Nitric and Nitrous Acids, and the Oxides of Nitrogen.

In close relation to substances like sulphurous and sulphuric acids, we have the corrosive acids, nitrous (HNO_2) and nitric (HNO_3). These, however, being volatile acids, they and the oxides of nitrogen into which they readily decompose, may be employed with advantage in processes of disinfection carried out by fumigation.

The ease with which the acids decompose, either by heat or when brought in contact with certain metals yielding large quantities of their gaseous oxides, render them peculiarly applicable for the disinfection of spaces not occupied as habitations, and they have consequently been employed to a very considerable extent in sweetening the air of mortuaries.

The oxide of nitrogen most readily obtained from nitric acid is nitric oxide (NO), and it is best prepared when the acid is brought in contact with shavings of copper, such as I have in this retort. On adding the acid, you perceive at once energetic action takes place, large quantities of gas being driven into the receiver. At first a small quantity of a brown vapour is obtained, but this, as you perceive, passes away. This brown substance is, however, of considerable importance in our disinfecting processes, as it is highly charged with oxygen gas, with which it readily parts on being brought in contact with reducing agents, and so may be made to play the part of a carrier of oxygen from one substance to another.

This brown gas is termed nitric peroxide (NO_2), and you will readily see its formation when I expose one of the vessels in which the nitric oxide was collected to the air, when dense brown fumes of the peroxide are at once formed. In decomposing nitric acid with copper therefore, unless this be carried out in a vessel out of contact with the air, the nitric oxide at first produced is at once converted into the peroxide; as you see when I pour the acid upon the copper in this open dish. The direct oxidising properties of NO_2 may be best seen by bringing it in contact with sulphur dioxide gas, when the brown fumes of the first gas disappear, and crystals of sulphur trioxide are produced—

$$NO_2 + SO_2 = SO_3 + NO.$$

In the oxidation of nitric oxide there may also be produced greater or less quantities of nitrous anhydride (N_2O_3), which forms nitrous acid. This anhydride also apparently possesses disinfecting properties, and even very small quantities are capable of arresting fermentable changes, and of sterilising fluids in which organisms are growing. By oxidation, nitrous acid and most of the oxides become converted into nitric acid, which may be regarded as the most active oxidising agent of the group.

Substances which do not readily undergo oxidation, such as charcoal and iodine, are readily oxidised by this acid. I have here some recently warmed charcoal, which I pour out on the plate, and then allowing a few drops of the strongest nitric acid to fall upon the little cone so formed, you perceive that after a second or two vivid combustion commences, due to the oxidation of the charcoal. This oxidising action is extremely active with organic substances, even when the vapours only of the acid are employed, the acid rapidly attacking and destroying the organic substance. This is seen when we boil some strong nitric acid in a test tube which has its mouth gently plugged with some horse hair; very soon the warm vapours of the acid commence to destroy the hair, which finally undergoes oxidation and combustion.

Fumigations by the vapours of nitric and nitrous acids were early employed for disinfecting purposes, and were used by Drs. Carmichael Smith and Menzies for disinfecting the prisons and hospitals after an outbreak of fever, in 1780; and again in the case of typhus fever which broke out in the English navy, extending from 1795 to 1799. For the production of the fumes, sulphuric acid was gently heated in porcelain vessels, and nitre was dropped in from time to time; these vessels being carried round the wards and rooms, or placed in convenient positions in the chambers. According to Dr. Angus Smith, the fumigations carried out by the higher oxides of nitrogen are dangerous, and cases of death have occurred due to the employment of these fumes, even when mixed with a considerable excess of air.

Metallic Salts.—These substances may act as disinfectants in two ways, either as absorbents of the noxious gases produced in decomposition, as with lead acetate, bismuth nitrate, and quick lime, or as true germicides like mercuric chloride. Such substances as bleaching powder and potassium permanganate do not come under the first of these divisions, as they simply act as the producers of other substances, namely chlorine and ozone. They were, therefore, considered at a previous part of the course.

Of all the metallic salts the one which appears from its properties to have taken the most important position is undoubtedly mercuric chloride, or corrosive sublimate as it is more commonly called ($Hg\ Cl_2$). This salt is very soluble in hot water and in alcohol, its solution in the first of these depositing beautiful long shaped crystals, of which you have specimens on the table. Although it dissolves readily in hot water, it requires from 15 to 16 parts of cold water to effect its solution; should, however, ammonium chloride be mixed with it, the mercuric chloride forms with that substance a double chloride called sal alembroth ($HgCl_2$. $6NH_4\ Cl\ H_2O$.), which dissolves more readily in water.

Unfortunately, mercuric chloride possesses extremely poisonous properties, death sometimes being caused by doses of three to four grains of the salt. The antidote employed is albumen administered as white of egg, from the fact that the mercury salt apparently forms an inert compound in the stomach with this substance. This compound of albumen and mercuric chloride resists putrefaction for a much longer time than albumen by itself. This property at once shows us the preserving action of mercuric chloride, whether it be employed for the destruction of putrefying causes in animal matter, or for the prevention of decay in vegetable matter, by uniting with the vegetable albumen in the sap.

Many experiments have been made on the value of mercuric chloride as a disinfecting agent, but from the difficulty of having all collateral circumstances similar, it is difficult to fix absolute values to such comparisons. Its activity in this direction, however, does not apparently cease till we have the salt in a state of dilution of 1 part in 50,000, and quantities as small as 1 part in 20,000, exert a considerable check on the growth of organisms in putrescible liquids. From this activity, when in such small quantities, it forms a very valuable disinfectant, and has been used without danger in the dressings, &c., after surgical operations, more especially as the compound sal alembroth. When the bacteria, &c., causing the putrescence have once disappeared, there is apparently no tendency to their reproduction, if the mercury salt has been employed in sufficient quantity; it therefore may be regarded not only as an antiseptic but as a distinct germicide.

The coagulation of albumen by a solution of mercuric chloride is easily shown you, and you perceive that a drop or two of this dilute solution at once causes the coagulation of the liquid in the glass beaker. The presence of the salt may be recognised by the brilliant red precipitate of mercuric iodide which it gives with a solution of potassium iodide, this precipitate dissolving in excess of the latter reagent, forming a double iodide.

The action of mercuric chloride in very dilute solutions becomes ineffective when employed in the presence of large quantities of fats or of albuminous matter. This arises from the formation of sulphur compounds in the decomposition of these substances, and the consequent formation of sulphide of mercury, with, of course, the withdrawal of a certain quantity of mercury from the disinfecting liquid. From its extremely poisonous nature it must be used with caution and only by experienced hands. As a germ killer it is thoroughly active in proportions of 1 part in 1,000, and for spores 1 part in 100.

Ferric Chloride ($Fe_2\ Cl_6$), *Zinc Chloride* ($Zn\ Cl_2$), *Chloralum.* — Certain of these metallic salts act, as has been already shown, as absorbents of the noxious gases given off in decay; others as disinfectants by indirect oxidation, desiccation, or killing the putrefactive cause.

Ferric chloride, in its action, may be regarded as an indirect oxidiser, becoming itself reduced. It was originally obtained only in a state of solution, and this being to a certain extent acid, has prevented its adoption to any great extent. Now it may be obtained in a solid condition, readily soluble in water, and yielding a solution almost neutral in character.

It may be recognised by very distinct reactions which I can very readily show you here. In this glass I place a solution of potassium ferrocyanide ($K_4\ Fe\ Cy_6$), and adding a few drops of ferric chloride, you see at once the production of the deep blue—Prussian blue, or ferric ferrocyanide. A solution of ferric chloride liberates iodine from its compound with potassium, as you may see on my adding a little ferric chloride to this solution of potassium iodide, when we at once obtain a dark-brown sherry-coloured fluid; on exhausting with ether, the iodine is at once extracted.

From its indirect oxidising power it is efficacious in the destruction of the reducing gases given off in decay, causing their oxidation. Thus if we bring a solution of ferric chloride in contact with sulphur dioxide in its solution in water, and then divide the solution, on testing one portion with potassium ferro-

cyanide, we get no longer a dark blue but a light blue precipitate; whilst on adding barium chloride to the other portion, we get a precipitate of barium sulphate, showing us in the first case the reduction of the ferric iron to ferrous, and in the second the oxidation of the sulphurous to sulphuric acid. The employment of ferric chloride is rendered sometimes inconvenient by its decomposition with water containing alkaline carbonates, which at once cause a deposit of the hydrate and carbonate of iron; under certain circumstances, however, this change may be rendered practically useful.

Other iron salts may be employed, as in the case of ferrous sulphate ($Fe\ SO_4$) which has a tendency to absorb oxygen, becoming itself oxidised. It may be employed to absorb such gases as oxygen, nitric oxide, and hydric sulphide.

Zinc chloride ($Zn\,Cl_2$), or "Burnett's disinfecting fluid," acts both as a germ-killer and an absorbent, as it absorbs such gases as hydric sulphide, ammonia, and other products of putrefaction. It arrests also decay in vegetable and animal substance, readily coagulating albumen, as you perceive on my adding a few drops of its solution to the white of egg in this vessel.

The solution known as Burnett's fluid differs considerably in strength, various of the solutions when examined having been found to vary from 47 to 53 and 69 per cent. of zinc chloride in the solution. For the disinfection of sick rooms it is customary to employ a quantity of the solution containing one part of zinc chloride, to which has been added 50 parts of water, and one part of the chloride diluted with 100 parts of water for the disinfection of closets, &c.

The substance employed under the name of "chloralum" is apparently a mixture of the chlorides of aluminum, copper, lead, iron, and calcium, the aluminum chloride being in excess. From its composition it may be regarded as acting quite as much as a deodoriser as a disinfectant, and its properties in this direction have been strongly advocated by Mr. Wanklyn. Its employment, however, in England has considerably decreased of late years.

In connection with the preservation of animal substances there are two substances of considerable importance; these are boric or boracic acid, and arsenious acid. The former of these, not only by itself, but also indirectly in a state of combination as borax $Na_2O\ 2\ (B_2O_3)$, has been very extensively used as preservative agents. It has also been employed associated with glycerine in a compound termed "boro-glyceride," introduced by the late Professor Barff. This substance is prepared by heating together molecular weights of glycerine and boracic acid; its composition is $C_3H_5.\ BO_3$, and it has been found very efficacious in preserving milk, fish, and flesh.

Boracic acid and its sodium compound may be recognised by the peculiar green colour which their solutions in alcohol impart to flame. For this test the boracic acid must be previously freed from combination with other substances, and this is generally done by treatment with a stronger acid, like sulphuric acid.

I have in this vessel a solution of borax in alcohol, to which I now add some sulphuric acid; in pouring this on a plate and igniting the alcohol, you see the very distinct green tip which the flame possesses, especially if a little of the fluid be removed on the end of a glass rod. Another reaction is the change of colour which boracic acid produces on turmeric paper when dipped in solutions of the free acid; on gently drying this slip of the paper on a porcelain lid after it has been dipped in the acid, it gradually acquires a red colour, and when touched with a drop of potash solution a spot of a deep green colour is obtained.

Boracic acid forms an excellent disinfectant on account of its being non-poisonous, and without any irritating action. The recent work of Mr. Newman, at Dorpat, and others have shown that quantities of from two to four grammes of boracic acid per 100 grammes of the putrescible liquid is sufficient for preventing the development of bacteria.

Arsenious Acid or Oxide ($As_2\ O_3$) has been employed under special conditions as a preserving agent, but its very poisonous properties prevent its use to any great extent. It has been employed for the destruction of insects infesting grain crops by washing with solution of the acid. In Scotland, at the present time, it is pretty extensively employed for dipping the sheep, so that it may act as a preservative not only for the wool, but also to the skin and hoofs of the animal in wet weather. Its chief use as a preservative is for the embalming of corpses for medical purposes, the solution of the acid being injected into the body by one of the main arteries.

The acid is only slightly soluble in water, but may be more readily dissolved by warming

with its equivalent quantity of caustic potash or soda, when it dissolves forming an arsenite of the metals. From the poisonous nature of the substance it must be employed with great care and only in certain cases. The detection, however, of arsenic, when in decided quantities, can be effected with great ease in the following way. The substance suspected to contain it must be boiled with hydrochloric acid, or with an alkali; if with the latter, the solution after boiling must be rendered acid with hydrochloric acid, and then slips of copper placed in the boiling solution. Should arsenic be present a grey deposit or coating is found upon the copper. Such a change you see going on before you, and if I now dip this bright slip of copper in the solution you at once see the grey deposit of metallic arsenic forming on it. There are several other disinfectants derived from metallic salts which, had time permitted, I should have liked to have brought under your notice; I must content myself, however, by merely mentioning their names. The most important among them are sodium chloride (Na Cl), sodium silicate ($Na_4 Si O_4$), aluminum acetate, and lead acetate [$Pb(C_2 H_3 O_2)_2 . 3$ Aq.].

Disinfectants Derived from Organic Substances.

Of these, the one which takes the principal place both from its active properties and from its wide application is undoubtedly carbolic or phenic acid, or, as it is sometimes called, phenol ($C_6 H_6 O$). This acid constitutes a great part of ordinary commercial kreasote which as its name indicates (*κρέας*, flesh, and *σωζεἰν*, to preserve) is itself a disinfectant. The acid is extracted from that portion of the oil of coal tar which distils over between 300° and 400° Fahr.; it is liquid at the ordinary temperature, but solidifies when cooled to a mass of long colourless needles, which again easily undergoes liquefaction on warming.

The simplest test for phenol is the reaction between a solution of that substance and ferric chloride, with which it yields a purple blue colour; this you see produced when I add a drop or two of this solution of carbolic acid to the large volume of water containing ferric chloride.

Another very delicate test is the reaction with bromine water, which gives a white precipitate of tribromophenol ($C_6 H_3 Br_3 O$).

Carbolic acid is very largely and very commonly used as a disinfecting agent, both in its liquid condition mixed with water, and in the solid condition of powder mixed with other substances. As already mentioned, "Mac Dougall's disinfectant" consists of this substance mixed with sodium sulphite; and Calvert's celebrated disinfecting powder consists of pure clay saturated with about 15 per cent. of carbolic acid.

The solubility of the acid in water is small, but it dissolves more readily in alcohol, glycerine, and oil, the very strong solutions of the acid in this last substance being extremely useful, as it hinders the rapid volatilisation of the carbolic acid when spread over putrid sores, or upon dressings, and at the same time checks its absorption by the system, thus rendering its toxic effect more difficult. The effect of a strong solution of carbolised oil is less felt upon the system than that of a weak aqueous solution of the acid.

The use of the aqueous solution in so-called antiseptic surgery has been much advocated by Sir Joseph Lister, who employs solutions varying from $2\frac{1}{2}$ to 5 per cent. of the acid in water for antiseptic purposes. According to the experiments of Mr. John Dougall, carbolic acid acts more as a temporary preventive than as a true germicide. It preserves, at the same time hindering and stopping putrefaction, but on volatilising it leaves the material liable to be again acted on with impunity by the putrefactive agents. The acid, however, does not volatilise with any great facility, so that this must be regarded as a minor objection to its use.

You are all perfectly familiar with the ease with which solutions of carbolic acid can be employed in the form of spray, and the very successful employment of it in this form by Sir Joseph Lister, and other surgeons, during surgical operations. The power of penetration of the acid not only in the case of dressings, but apparently also in the case of tissue, render it peculiarly applicable in these operations.

A solution containing 1 part of the melted crystals to 20 of water is found perfectly efficacious for ordinary disinfecting purposes.

From a chemical point of view, what is generally termed carbolic acid may be regarded as phenylic alcohol, and its composition expressed as such, namely, C_5H_6 (OH).

Closely allied to carbolic acid we have many other agents, the most important of which are creosote, the tars and resins abstracted from different woods, pyroligneous acid, and picric or nitrophenic acid, $C_6 H_3 (NO_2)_3O$; this last so called from its derivation from phenic acid

by substituting three proportions of the group (NO_2) for three atoms of hydrogen in the acid.

The action of the tars and creosote is very similar to carbolic acid, but of a weaker character.

Picric acid may be obtained by boiling carbolic acid with nitric acid, the solution in cooling depositing beautiful yellow crystals, of which you have some fine specimens on the table. The acid is not very soluble in water, but is soluble in alcohol, the solution imparting a bright yellow colour to the skin and many other organic substances. On dipping this skein of silk in a warm solution of the picric acid and removing it again you see that it is now dyed a bright yellow colour. From the weak nature of its antiseptic properties, and from its imparting this yellow colour to organic substances, it is hardly ever used as an antiseptic agent.

Terebene.—Under this name may be classed a large number of substances derived from the essence of terebenthene by the action of sulphuric acid. This substance, and its homologues, act through the small quantity of available oxygen which they possess, giving off this substance gradually, in a manner which has induced certain chemists to believe that the oxygen is evolved in the condition of ozone. Favourable results with such substances have been obtained by Mr. Charles Kingzett and others, and a disinfecting substance, introduced by that gentleman under the name of "Sanitas," probably owes its disinfecting properties to such actions. When oil of turpentine is exposed to the air it slowly becomes solid, absorbing oxygen and becoming converted into resinous substances. Among these substances there exists apparently a substance, camphoric peroxide, $C_{10}H_{14}O_4$, which undergoes decomposition in the presence of moisture, with the formation of hydrogen peroxide:—

$$C_{10}H_{14}O_4 + 2H_2O = C_{10}H_{16}O_4 + H_2O_2$$

This is the reaction taken advantage of by Mr. Kingzett in the formation of his disinfectant, which is made by passing air and steam through oil of turpentine, thus obtaining a fluid rich in hydrogen peroxide. The substance many of you may have heard spoken of as eucalyptol, derived from the Australian gum tree, *Eucalyptus*, contains a similar oil, which, no doubt, produces hydrogen peroxide in the presence of moisture in the same way.

Other substances which have lately been introduced, such as thymol, a phenol derived from the essence of thyme, menthol, from peppermint, are substances more or less similar in their action. They are apparently less decided in their action than carbolic acid, but are suitable as deodorisers, as they possess much more agreeable odours.

Salicylic Acid ($C_7H_6O_3$).—This acid may be obtained from the oil of spiræa ($C_7H_6O_2$), from which it differs in containing an atom more of oxygen; but it is best prepared from carbolic acid by heating sodium phenol in a current of CO_2 gas, the temperature being gradually raised from 100° C. to 180°C. Phenol at first distils over, till the temperature reaches 250° C., when on stopping the distillation, disodium salicylate is found to remain as the residue in the retort.

$$2(C_6H_5ONa) + CO_2 = C_7H_4Na_2O_3 + C_6H_5OH.$$

It is slightly soluble in water, more soluble in glycerine, alcohol, and ether.

The antiseptic and preserving qualities of salicylic acid were first pointed out by Kolbe, and have been more lately investigated by Bucholtz, Pasteur, and Herroyne, who have employed it largely in France for the preservation of animal substances, even when of large size. The quantities of the acid necessary for the sterilisation of different fluids vary very much with the nature of the fluid, and with the experimenter. Bucholtz has stated that 1 part per 600 of liquid was sufficient to stop the development of bacteria in the liquid employed by himself and Professor Pasteur; but in an infusion of tobacco it required 1 part to 362 parts of the solution for absolute sterilisation. Under the same conditions, with the sodium salicylate, Bucholtz did not obtain sterilisation under one part of the salicylate to 217 parts of the liquid; and in the case of the infusion of tobacco, 1 part to 161 parts of the fluid. Salicylic acid has been extensively employed in France for the preservation of beef, fish, poultry, and milk, with very successful results; it has also been used for the prevention of fermentation in wine, beer, &c.

The chemical action which apparently takes place when the salicylic acid acts as a disinfectant is its easy decomposition into phenol and CO_2, the former acting as the disinfecting agent. It also possesses qualities which render it particularly applicable, as it is inodorous, nearly tasteless, and is not poisonous in moderate doses.

Having now, so far as time permits, brought before you certain of the more important chemical properties of some of the common disinfectants, I would, in conclusion, say only

a few words in general as to the manner in which these properties may be utilised. This, as you will readily see, can only be done in a very general manner, as to enter into the full details necessary for the carrying out of disinfection in all its branches would require another distinct course of lectures. I will, therefore, limit myself in my observations only to such points as might occur in the case of illness, or suspected poisoning by the products of deoomposition.

In the case of illness from some contagious sickness, all clothing, sheets, evacuations, in fact all matters coming from, and materials belonging to, the patient, must be subjected to disinfection before they leave the sick room. Any materials of no value should, by preference, be burned.

For ordinary household purposes, carbolic acid, zinc chloride, zinc sulphate, potassium permanganate, chloride of lime, and sulphate of iron, or green vitriol, will be found the most useful, and may be employed and kept in approximately the following quantities:—

Carbolic acid, four ounces of the melted crystals to the gallon of water.

A quart of solution of zinc chloride (Burnett's disinfecting fluid) in three quarts of water.

A solution of one pound of zinc sulphate in a gallon of water.

Solid potassium permanganate, which may be dissolved when required; or a solution of the same as Condy's fluid.

Solid chloride of lime.—A solution of this may be made at any time by adding the salt to water till it is saturated.

A solution of two pounds of ferrous sulphate in a gallon of water.

In the employment of all such disinfectants we must be certain that they are thoroughly mixed with the material to be disinfected; and this material, if it is to be employed afterwards for any purpose, as in the case of sheets, towels, &c., must be left in contact with the disinfectant for some time. For the purification of rooms after sickness fumigation with sulphurous acid is apparently the best, as it is more easily carried out in ordinary households than employing either nitrous or chlorine fumes. In the case of an ordinary room—clothes, &c., having been carefully removed for treatment in another way—the doors and windows should be shut, some sulphur placed in an iron shovel, or other metallic dish, alcohol or a red-hot coal placed upon it, and the mass lighted. The room should remain thoroughly closed for about three hours; but this, and the amount of sulphur to be used, will depend on the size of the room. A fair quantity of sulphur to be taken is 1 lb. to every 1,000 cubic feet of space to be disinfected, which gives a little over 1 per cent. of the gas in that quantity of air. The late Dr. E. Baxter concluded, after a long series of experiments, that sulphur dioxide was the best disinfectant for air spaces, but that it was necessary that the air should be thoroughly saturated with the gas. The disinfection of a room by chlorine gas is somewhat more inconvenient, not only from the fact that the gas acts very rapidly on metallic articles remaining in the room, but also that it is necessary to have some arrangement for warming the mixture evolving the chlorine, when that gas is required in any quantity. Under these circumstances it would be better to employ the mixture which I described to you under the name of "bromodine," which gives off bromine vapours merely by the addition of water to the mixture.

In the case of articles of clothing, linen, curtains, &c., these should be subjected to the heating process, which can be arranged for in all well regulated towns by the medical officer of health. In country or remote districts, where such facilities do not exist, in cases of emergency the clothes, bedding, &c., should be spread out in small chambers or boxes, and subjected to a thorough saturation by sulphur dioxide. If the process of soaking or boiling articles of clothing be adopted, then it is better to add some disinfectant to the water. For this purpose, 1 gallon of strong chloride of lime solution to 20 gallons of water may be employed; or 2 parts of carbolic acid to 100 parts of water. Even with the employment of such chemical agents in the water during the washing of the clothes, it will always be found advantageous to subject these articles afterwards to a baking process, where the temperature is allowed to rise at least to between 115° and 124° C.

For the mere destruction of offensive smells many agents may be employed, and a great number of the products usually sold as disinfectants, simply serve this purpose, and must therefore be regarded more as deodorisers than as true disinfectants or germicides. Such substances act by supplying an odour which, by its strength, counteracts that of the foul smell, in distinction to those which gradually evolve a gas such as oxygen, or ozone, or chlorine, which has a direct destructive action on the putrefactive substances produced.

For the disinfection of articles of food, the simplest results may be obtained by a thorough process of cooking. Milk may be thoroughly boiled, and water should be subjected to a process of boiling, and afterwards to filtration, which will partially destroy the peculiar and somewhat insipid taste which boiled water possesses. In the case of meat, it should be thoroughly roasted, stewed, or fried. These remarks apply merely to suspected cases in the ordinary household; the question of the preservation of food, either in a cooked condition in tins, or by being subjected, as already described, to great cold, having now become almost a special industry, would be too large a question to enter upon, and somewhat out of our present course.

In concluding this short course of lectures, I must return my best thanks to my friend, Mr. Herbert Jackson, for the care and trouble he has taken in the preparation and carrying out of the various experimental illustrations that have been put before you.

Miscellaneous.

CONSUMPTION OF COCOA.

It may be noted that while the consumption of the other dietetic articles used for beverages—tea, coffee, and chicory—show a decline last year, cocoa is marked by a considerable increase. This is remarkable, since for about six years, from 1875 to 1879, it remained pretty stationary at about 10,000,000 lbs., but after 1880, it began to make steady progress, advancing from 10,500,000 lbs. in that year to over 15,000,000 lbs. last year. Of powdered cocoa and chocolate we received 1,332,000 lbs., chiefly from Holland. We also imported 3,211 cwt. of husks and shells of the cocoa bean, which are also used up for cheap cocoa. There are about ten chocolate and cocoa manufacturers in Holland, whose yearly requirements of cocoa beans may be estimated at 3,000 tons, in round numbers, principally of Guayaquil, Caracas, and Domingo kinds.

They mostly manufacture cocoa preparations, known by the name of soluble cocoa, cocoatine, and cocoa powder, viz., the roasted and powdered cocoa beans, deprived of most of their natural fat, or the cocoa butter, which is used as a valuable ingredient by manufacturers of chocolate and cocoa sweetmeats, and also for pharmaceutical preparations. In the early part of this month no less than 25 tons of this cocoa butter was sold in Holland, and 50 tons in London.

The oldest of the Dutch cocoa works was founded on a small scale more than a century ago, and most of the other works have existed from forty to sixty years, but all of them remained insignificant until the before-mentioned powdered preparations found their way to foreign countries, especially England and Germany, where certain Dutch brands of powdered cocoa have been very well received and enjoy a large sale.

There are people who suppose that the superiority of the Dutch cocoa powder is to be attributed to a peculiar mode of manufacture, different from the methods followed in other countries. The idea to extract the fat from the roasted cocoa beans, and to sell the powder, is said to have originated in the brain of a Dutch chocolate maker about 1830. It is now generally practised in France and England. The average consumption in the United Kingdom last year per head of the population was, of cocoa, 0·41 lb.; coffee, 0·86 lb.; tea, 4·87 lbs. Tea brings into the revenue £4,500, coffee only £200,000, and coffee mixtures and chicory, £5,273. The latter seem to be declining.

MANUFACTURE OF PANAMA HATS.

The United States Minister in Peru says that the art of manufacturing Panama hats had its origin in Guayaquil, and from thence was imported into Peru some fifty years ago. Ten years back it was a flourishing business, but its importance has greatly diminished. This decline is said to be owing to the progress made in the European manufacture. In Brazil, where the sale of the Panama hat was once sure and profitable, an Italian straw hat may be obtained for a franc and a half, arranged according to the fashion, while the most ordinary Panama hats cost about two francs each. The inhabitants of Mayobamba, Sarapoto, and Somas, who formerly lived on the hat industry, have considerably diminished, and at the present day they turn their attention to the more lucrative gutta-percha industry. The preparation of the straw for the manufacture of hats is a somewhat delicate operation. The fibral parts are separated, and for this purpose a hook is used resembling a hair-pin. The strip separated by the two points is that used, and all the straw used in the manufacture of a hat is cut in the same way, and must have the same width. These shreds of straw are submerged in boiling water for six hours, then exposed to the dew, and afterwards dried in the sun. The value of the Panama hat increases in proportion to the fineness of the straw. The ordinary hats have three numbers, No. 1 being the least fine. In Mayobamba the following prices per dozen are realised:—No. 1, about 19s.; No. 2, 26s.; and No. 3, about 38s. To make a hat described as No. 1, three days' labour are generally required; for No. 2, four days; and for No. 3, five days. Some workers, practised from infancy, and exceptionally quick, are able to make a No. 3 hat in a day and a-half. The price of the

hats in Mayobamba, called "fine," vary from £1 14s. to £8, as they require from one to three months to make.

THE FORESTS OF TUNIS.

The forests of Tunis, which cover a considerable part of the surface of the country, were, until the French occupation, subject to no supervision, and suffered from the many causes resulting from the want of that supervision. In 1883, the French, alive to the importance of preserving what remained of these forests, which are the property of the State, placed them under the management of a separate department, which has explored their extent and demonstrated that they are an important element of national wealth. Her Majesty's Consul at Tunis, in his last report, says that the explorations of the new department have resulted in the division of the forests into two main groups, one consisting of the cork tree, and deciduous oak locally known as "zen," covering the north-western angle of Tunis where it abuts on the Algerian frontier and the sea, inhabited by the Kroumirs, and separated from the rest of Tunis by the River Mejerdah. These trees grow in a stratum of sandstone, which again reposes on the upper chalk, and they completely disappear where the latter stratum crops to the surface. They cover an area of about 360,000 acres, on 330,000 acres of which flourishes the cork tree, and on 30,000 the "zen." The former is generally found on the southern slopes, while the latter are found on the northern slopes of the mountainous region and in the hollows of the valleys. South of the River Mejerdah both trees disappear, and give place to the pine and a species of evergreen oak. The principal forest groups are found in the following places:—Zaghouan, Djuggar, and Jebel-el-Erssaas, not far from the city of Tunis; Kessera and the Zlass Mountains further south; Sidi Yussef, Wady Melégue, Nebeur, and Hydra, farther towards the west. These latter forest groups are in a more neglected state than the former, no control being exercised over the cutting down of trees or stripping them of their bark, and goats being allowed to roam everywhere. It is to the cork forests that the attention of the new administration has been mainly directed. They are situated in a country with a very sparse population, estimated at about 12,000, or one individual to every thirty acres. Much has been done during recent years in improving the condition of the cork forests; roads have been cut through them, and at stated intervals spacious alleys have been made to serve as a means for arresting the spread of the destructive fires which frequently ravage them. Much progress has also been made in barking the oak trees, an operation which consists in stripping the rough bark of the trunks of the trees to the height of five or six feet from the ground. This virgin bark is valueless, and only for ten years after the trees have been robbed of it is the inner bark available for commercial purposes, the trees giving a crop of cork every ten years. The worst enemies of the forests are goats, and some French colonists have taken steps to exclude these animals from their estates, and the result has been that shrubs which never attained the height of more than two or three feet have, in four or five years, assumed the dimensions of trees. This is particularly apparent in the large domain of Enfida, near Susa, belonging to the Franco-African Company, where the *thuya*, a species of cypress which covers much of that domain, from a dwarf shrub has now, within the space of six years, attained a height of from twenty to twenty-five feet. The French railway company which owns the line running from Tunis to the Algerian frontier has succeeded in planting a considerable number of the *Eucalyptus resinifera* and *Acacia cyanophylla*. It is estimated that 300,000 trees have been planted along the railway line. Consul Sandwith says that the cost of planting an acre with the eucalyptus amounts to £20 sterling, about 1,600 trees going to the acre of nursery ground. It is estimated that at the end of twenty years 600 trees will have survived, worth about eight shillings each. The bark of the *Acacia cyanophylla* is rich in tannin. In the whole of southern Tunis there exists but a single forest formed of a species of acacia. It is situated about five miles inland from Sfax, and covers an area five miles long by a little over a mile in width. This forest, which was formerly much more extensive, is protected from the northerly winds by high land, and the trees grow in clumps in depressions of alluvial soil. Although they only attain a height of ten feet, the trunks furnish planks eight or ten inches wide, of an exceedingly hard grain, and capable of taking a fine polish.

Obituary.

Robert Hunt, F.R.S.—Mr. Hunt, late Keeper of Mining Records at the Museum of Practical Geology, died at his residence at Chelsea, on Monday, 17th inst. He was born on September 6, 1807, at Devonport, and his well-known work on "Photography" was published so long ago as 1842. He was the author of numerous works, one of these being the "Handbook of the Great Exhibition of 1851." He also edited three editions of "Ure's Dictionary of Arts, Manufactures, and Mines." In 186c he received a handsome testimonial in recognition of the value of the annual volumes of Mineral Statistics which he originated. Mr. Hunt was a member of the Society of Arts from 1852 to 1878, and he was elected on the Council in 1861. On December 17, 1862, he read a paper before the Society on the "Mines, Minerals, and Miners of the United Kingdom." The Mining Record Office was abolished in 1883, when Mr. Hunt retired on a pension.

Journal of the Society of Arts.

No. 1,823. Vol. XXXV.

FRIDAY, OCTOBER 28, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

MOTORS FOR ELECTRIC LIGHTING.

Four Gold Medals and Four Silver Medals are offered by the Council of the Society of Arts for Prime Motors suitable for electric-light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows:—

1. The motors will be divided into two classes, *A* and *B*. Two gold and two silver medals will be allotted to each class.

(*A*.) Motors in which the working agent is also produced.

Steam.—Ordinary portable or semi-portable non-condensing engines.
Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer.
Hydro-carbon vapour.
Liquid hydro-carbon.

(*B*.) Motors to which the working agent must be supplied.

Steam.—Detached engines, non-condensing, without boilers.
Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas.

Hydraulic.—Water motors.

Air.—Compressed-air motors.
Exhaustion motors.

2. Each class will be sub-divided into two groups—those declared to develop not more than 10 h.p., and those which will develop more than 10 h.p. and less than 20 h.p. Each motor will be worked at or about the power at which it is entered.

[The horse-power herein mentioned is equivalent to 33,000 lbs. raised one foot high in one minute, as measured on the brake.]

3. For four-horse power and under, the entrance fee will be £10; above four-horse power, the entrance fee will be £2 10s. per h.p. The fees to be paid on entry.

4. No competition will be held unless ten motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The Council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the Regulations of the Royal Agricultural Society.

a. All motors or producers subjected to more than a nominal pressure must be fitted with a pressure gauge. Before any motor can be worked, the pressure gauge must be verified by the judges.

b. There is no restriction as to the construction of motors, boilers, or producers, but the judges must be satisfied that the bursting strength of them is at least four times the working pressure, and that a hydraulic test of one and a half times the working pressure has been satisfactorily applied, if considered desirable.

c. Each exhibitor must declare the greatest pressure at which he proposes to work his motor.

d. No old boilers, that is boilers that have manifestly been at work for a considerable time, will be admitted without special thorough examination, and a certificate of safety from the judges.

e. Each boiler, of whatever form or size, must be provided with the following mountings:—

Two Safety Valves, each of sufficient size to let off all the steam the boiler can generate, without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set.

Two Sets of Gauges for ascertaining the water level.

One Steam Pressure Gauge, which must be tested and verified by the judges before the boiler can be used.

A Half-inch Cock, terminating in a half-inch male gas thread, for the purpose of receiving a testing pump.

One Check Feed Valve, immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water-level, or where there is a length of feed pipe between the engine and boiler.

f. The judges reserve to themselves the power of affixing any gauges that the peculiar nature of the machinery may call for, with the object of ensuring safety, and of obtaining information.

g. Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges require it.

h. Shafting, belts, gearing, high - speed machinery, and any other exhibits likely to prove dangerous, shall be securely fenced and protected to the satisfaction of the judges, but such approval shall not relieve the exhibitor from his own liability.

8. The points of merit considered of the greatest importance are—

a. Regularity of speed under varying loads.
b. Regularity of speed during the various parts of one revolution, or one cycle of revolutions.
c. Power of automatically varying speed to suit arc lights.
d. Noiselessness.
e. First cost.
f. Cost of running.
g. Cost of maintenance.

[In estimating the comparative value to be allotted to each of these points of merit, the judges will give due consideration to the characteristics of each kind of motor, steam, gas, water, &c.]

9. The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal of the Society of Arts*. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the Society, all claims in respect of damage (if any) resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the arrangements or in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June, 1888. Entries must be sent in by the 21st December, 1887.

13. All costs of fitting up and working the motors must be borne by the exhibitor. The Society will provide the brakes, indicators and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

Forms of entry can now be obtained on application to the Secretary.

Miscellaneous.

SACCHARIN.

The following notes on saccharin, a reputed substitute for sugar, by Edward D. Gravill, F.C.S., are taken from the *Pharmaceutical Journal*:—

The sample to which these notes refer represents, I believe, a portion of the first supply that has been offered to us as a commercial article, and may therefore be taken to represent the same as it at present occurs in commerce. I think it desirable to call attention to this fact, because of the wide difference I have seen in other samples obtained, I think, by special request some weeks ago, and which do not favourably correspond with the sample under consideration, being much more highly coloured, and in comparison having a very strong odour. Saccharin now occurs as a very pale yellow, nearly white, amorphous powder, free from grittiness, but giving a distinct sensation of roughness when rubbed between the fingers. It is not entirely free from odour, but this is very slight, and not at all objectionable, reminding one of a very slight flavour of essential oil of almonds. Its taste is intensely sweet and persistent, which in the raw state is followed by a slight harshness upon the tongue and palate. The sweetness is very distinct when diluted to 1 in 10,000. Under the microscope it presents no definite form of crystallisation. A temperature of 100° C., even if continued for some time, has no perceptible effect upon saccharin; it loses no weight, and undergoes no physical change. It fuses at a temperature of from 118° to 120° C., and at 150° C. forms a clear light yellow liquid, which boils a few degrees higher. At

the latter temperature dense white fumes appear, and a condensation of tufts of acicular crystals (some well defined) is found upon the cool surface of the apparatus. These crystals, except for a slight sweetness of taste, correspond in characters and tests to benzoic acid. The sweet flavour, I think, may be due to the presence of a very small quantity of undecomposed saccharin, carried mechanically with the fumes. The escaping vapours, which are very irritable, and give a more decided odour of hydride of benzole than the powder itself, also communicate a very distinct sensation of sweetness to the back part of the palate. Heated over the flame, with free access of air, saccharin carbonises and burns with a dull, yellow smoky flame, leaving a residue amounting to 0·65 per cent. of sodium salts. It does not reduce an alkaline copper solution, but, like glycerine, liberates boracic acid from borax, the latter salt dissolving saccharin readily in acqueous solution, due no doubt to a displacement of the boracic acid.

The strong acids, either hot or cold, show no characteristic colour reaction; the compound enters solution at the boiling point of the acid, and in the case of hydrochloric, shows a white granular separation on cooling. Sulphuric acid develops an uncharacteristic light brown colour.

The compound, like most of the organic acids, shows a characteristic reaction with ferro- and ferrid-cyanide of potassium. In the former case no change is perceptible until boiled, when a greenish-white turbidity appears with the liberation of small quantities of hydrocyanic acid. In the latter case a trace also of this acid is set free, with the formation of a very distinct green solution, the latter reaction being very perceptible with a few drops of a 1 in 1,000 solution of saccharin in water. Heated with lime, very distinct odours of benzoic aldehyde are developed.

Saccharin possesses very decided acid properties, and combines readily with alkalies or alkaline carbonates, forming anhydro-ortho-sulphamine-benzoates of the same, in the latter case at the expense of the carbonic anhydride, causing strong effervescence. These combinations are very soluble in water, the alkaline carbonate thus forming a ready medium for the solution of this acid, which alone is so sparingly soluble. Another advantage of some importance is, that while the harshness of flavour perceptible in a simple solution of the acid is destroyed, the great sweetness appears to be distinctly intensified and refined.

The following shows the solubility of saccharin in the various liquids quoted, all, with the exception of the boiling water, being taken at 60° F.:—

Boiling water..	0·60	parts per 100 by volume.
Cold water....	0·20	,, ,,
Alcohol ·800 ..	4·25	,, ,,
Rectified spirit ·838........	3·20	,, ,,
Ether ·717	1·00	,, ,,
Chloroform	1·49 0·20	parts per 100 by volume.
Benzene	0·40	,, ,,
Petroleum ether	insoluble.	

It is also sparingly soluble in glycerine and fixed oils, and to a greater or less extent in volatile oils. Benzoic aldehyde dissolves saccharin in large quantities.

The quantity of saccharin required to communicate an agreeable degree of sweetness, like sugar, differs with the material to be sweetened, but from half to one-and-a-half grains, according to taste, will be found sufficient for an ordinary breakfast cup full of tea or coffee infusion.

ALTERATIONS IN LONDON.

The Royal Commission* on the housing of the poor took especial care to be informed, in respect of London, as to the extent to which overcrowding existed in sleeping rooms. Bedrooms they cannot always be called, as the evidence showed how frequent it was for a family to have but one room. The amount of air per hour required for healthy breathing has been carefully calculated, and the smallest number of cubic feet of room per head tested in many ways. It is in the sleeping room that most people pass the highest number of hours out of the 24 without change. Sanitary science in regard to ventilation has come almost to be a question of how healthily to house the largest number of people in the smallest space, though it is not often the principles are intentionally put to the severest test. The condition of the houses occupied by the poor, many of them houses in once fashionable quarters,† but crowded by many families, were found, from evidence given before the committee, and from special inspections, to be sadly deficient in respect of breathing space.

Gradual decay, neglect, and wilful damage, had caused such dilapidations that in many districts houses were found to be absolutely unfit for dwellings. Two replies given by Mr. H. T. Boodle, in answer to questions by the Prince of Wales, will serve to illustrate this:—

> "913. Are those oldest or older houses in a fair state of repair?—Not at all, generally they are in a bad state of repair."
>
> "929. What is your opinion of the sanitary state of the older buildings?—I think, sir, in many cases they are almost beyond improvement, because it is useless to spend much money on buildings which must be pulled down, and which are so badly planned."

In many districts, short streets, rows, and courts, alluded to in the report of the Commission as unfit

*Appointed in 1884. The Select Committee of the House of Commons was appointed in 1881.

† *e.g.*, Gerard-street.

for tenements, have since then been demolished, and a large number of others have been condemned by the local authorities.

Apart from the unsanitary condition of houses themselves, the necessity of cutting new thoroughfares and widening old ones in consequence of the enormous increase of London traffic has involved the removal of many blocks, and in some cases of one side of streets of considerable length, *e.g.*, Dudley-street, King-street, Castle-street, Grafton-street, Crown-street, to make way for Shaftesbury-avenue, Cambridge-circus, and Charing-cross-road.

In a large number of instances the property has had to be purchased to effect the demolitions, but on some estates leases of rows and streets have run out, and the opportunity is being taken of pulling down the old houses, as on the Westminster, Cadogan, and Bedford estates.

At no time has there been such extensive pulling down of buildings as during the last few years. Among the more important demolitions that have been effected this year are the following:—

1. The north side of Buckingham-palace-road, from Eccleston-street towards Grosvenor-gardens (except four houses at each end), together with the cottages at the back, making a complete clearance to the line of "Eccleston-street East."

2. The north side of Mount-street, Mount-row, and the lanes between. The south side of Mount-street has been rebuilt gradually within the last two years.

3. The whole of Lower Sloane-street, both sides, Lower and Little George-streets, Sloane-market, and the adjacent courts, in all 240 houses.

4. Part of the west side of Sloane-street, north of Pont-street, together with the north side of Pont-street, west of Sloane-street. This, with the adjacent demolitions in Pavilion-row, Herbert-creseent, part of Hans-place, and many short streets, will entirely alter this locality.*

5. Cheyne-walk, Cheyne-row, Cheyne-street, and Cheyne-place, Chelsea.

6. Whitehall, north of the Palace, where Lord Carrington's house, the United Service Museum, and surrounding buildings stood.

Among the demolitions less extensive, but forming part of a plan of rebuilding are—

1. Flood-street, Chelsea.

2. Part of King's-road, Chelsea, west of Leete-street, and the south end of the west side of Leete-street.

3. Eight houses in Piccadilly, Nos. 117 to 125.

4. The site of the Junior Travellers' Club, Piccadilly.

5. Long's Hotel, Bond-street, for many years a well-known hotel only for gentlemen.

6. Part of York-street, Westminster.

7. Spring-gardens.

Of the houses demolished, some few had an interest from their age or their historic associations; among these may be noted—

1. Macclesfield-house, which was destroyed by fire.

2. The so-called Raleigh-house, Wandsworth.

3. Fairfax-house, Putney, the site of which is occupied by "mansions," with shops.

4. The Lawn, Putney, where now a new road is cut.

5. Southfield-house, Putney-bridge-road.

Queen Anne's-house at Wandsworth, Raleigh-house and Ivy-house, Brixton-rise, are in danger of being swept away, unless the public efforts being now made to save them are successful.

At no time, taking the widened London into calculation, has there been so much building, not even after the Great Fire of 1666. Local lines of rail, trams, and numerous routes of omnibuses, have completely altered the conditions of living, and the freeing of the bridges has helped to give a sudden impetus to building in many districts on the south side of the river.

It is interesting, and in many ways instructive, in connection with the question raised before the Commission, whether "the pig makes the sty, or the sty makes the pig," to compare the old dwellings occupied by the poor and those now erected as "artisan dwellings." They were either rows of cottages that once had gardens around them, that have since become courts, by a gradual process which was referred to in the *Journal* for Dec. 25, 1885 (vol. 34, p. 116), or they were houses once occupied by the well-to-do, even in some instances, as mentioned above, by people of position and fashion. Where many families crowded into a house originally intended for one, all feeling of home life naturally vanished. The same would occur in the courts. In the few cases where the gardens remain there is a considerable difference between the people dwelling in these houses as compared with those where they have degenerated into courts. In the artisans' dwellings it is found that the caretaker is able to check any neglect in cleanliness; but whatever the inside disorder, the outside of the large blocks, though not beautiful, at least remain the same, however careless the tenants. Looking on London as a collection of buildings, these artisan dwellings are admitted to be a great improvement on the alleys, courts, and neglected houses. But it is not everyone that is admitted to them. The kind of people that have been "ejected" are now to be found in Battersea, about Lavender-hill, and other places.

One very marked change in the rebuilding of London, in the case of houses of the better class, is the introduction and rapid spread of the "flat" system. The crowding of a population used to be calculated by the number of people per acre. Now with buildings six or seven storeys high, a number that would have been called "overcrowded" is not

* Those who take note of London changes will find much of interest at the present time by comparing the bye ways and courts in the neighbourhood of Pavilion-row, Exeter-street, and North-street, with the larger buildings that are gradually taking their place.

even "crowded." Victoria-street, built partly as far back as 1856, and not yet quite completed, was the first in which the system was introduced.

Among the latest are the mansions (Welbeck and Wycliff) in Cadogan-terrace, and Arlington-house near the north of Arlington-street, and the stately Whitehall-mansions now nearly complete.

From the art point of view, and the consideration of materials used, on which so much has been said before this Society, there are many changes to be noticed. The greater part of old London was built house by house to meet the requirements of the owner, the design being one to suit his own taste, or perhaps that of the builder. Then came the building of whole streets or squares, in which uniformity of some kind prevailed. There was the plain brick front, of which Baker-street, Gower-street, Brompton-road, Vauxhall-bridge-road, Kennington-road, Buckingham-palace-road, and Westbourne-terrace are examples. Some of these have iron balconies, some have not. Then the "portico" style, with the upper part of the house front broken only by mouldings round the window, or with perhaps a balcony. Such as these can be seen in Belgrave, Eaton, Chester, Eccleston, Lowndes, Ovington, Warwick, and other squares, and Ovington and Beaufort gardens. The relative size of the portico varies, the "enrichment" of the mouldings round the window varies, the shape of the window varies, some squares and streets have all throughout rectangular windows, while others have those of the ground floor arched.

The front may be left with the bricks showing, or covered, partly or wholly, with stucco; in some cases moulded up to the first floor in imitation of large stone blocks. But whatever may be the variations, all these buildings have a strong family likeness. The skyline may perhaps have a balustrade, but the whole of the front is practically flat; the windows are all in a line at regular intervals, and there is but the smallest attempt at ornament. There are no cosy bays that will hold a small table and two or three chairs, no staircase windows at different heights. There is nothing to break the monotony. Within the last two or three years, painting the fronts has not been confined to greys and stone colour, but brilliant colouring, sometimes startling, has been the fashion. The monotony has thus been somewhat overcome, but the structural sameness remains, which individual colouration seems rather to emphasise.

More recently there has been a return to red brick, and with this the use of granite and porphyry for columns, and of terra cotta for ornament. Glazed white tiles are also much used at the back of buildings where reflected light is needed. The brick so commonly used before was presumably intended to be yellow, for when a house is repaired on the front, the mortar is fresh "pointed," and a bright yellow tone is given to the bricks, which speedily returns to a dingy colour. Attempts have been made, apparently with success, to obtain the tone of red which in Elizabethan houses has stood so well. With the red brick has come a return to individuality of style. Nowhere can this be better seen than in the new Cadogan-square and Lennox-gardens, and the gradual rebuilding or refronting of Hans-place. The west side of Cadogan-square, which is not yet complete, is very marked in this respect. The bright look of our streets has much influence on our cheerfulness, and that is well known to have effect on health.

But while individuality is thus showing itself in the West, the case is just the reverse in the suburbs. Buildings, taken collectively, miles in length, have within the last ten years been erected all nearly alike. Rows of a hundred houses or more are put up by contract on one plan. The windows and doors and handrails are obtained wholesale. The ground floor has a bay window with Bath stone columns. Three windows of different sizes are in the front of the first floor, and a large proportion of the streets have no second. The "style" is not more than ten or twelve years old, but it has spread extensively. Three "estates" in the Fulham district, the Milkwood estate, Herne-hill, and the new district between Kimberley-road, Clapham, and Brixton Station, are examples. It may, perhaps, be known as the London suburban style. In the majority of cases, this good plan has been observed: the small back room on the first floor is fitted with a cooking range, so that should the house be occupied by two families, there is practically a second kitchen. Other noticeable features are that, in most rows, each house has a bath with hot and cold water pipes, and the cistern is well away from the closet. Where the little bit of front space is planted, and creepers are grown, the effect of these rows is pleasing. The ornamental rails on the low wall appear to have been cast by the mile, as the same pattern is to be seen on nearly all the new estates.

One structural feature worthy of notice, as indicating change of habits in mode of life, is the provision for shop space on the ground floor of large blocks of buildings. Two generations ago the house above shops, large shops even, were occupied by the shopkeepers. By degress they took to living away from their shops, and the upper parts of the houses were let as offices of various kinds. Many new blocks of houses are now built as residences over shops, but with this difference—the residences are in "flats," and are not occupied by the tenants of the shops. A block of red brick houses has just been completed on this principle between Sloane-square and Welbourne-terrace (Eaton-square), and others are in the course of erection in the Brompton-road. Several have been erected in Loughborough-park and Camberwell. In Piccadilly, near Devonshire-house, and at the bottom of St. James's-street, on the east side, there are also examples. The "Grand" was the first London hotel designed with shops on the ground floor.

Types of the different styles can be seen in close juxtaposition in the space of a few minutes' walk from the Brompton-road to King's-road. Where the Brompton and Fulham roads meet are the newly finished "Egerton mansions," with shops on the ground floor. Turning into Ovington-square, there is to be seen the old "portico style." The adjoining Lennox-gardens furnish examples of individuality of style in the return to red brick. Moore-street, which leads out of this, is an illustration of the flat front and balcony style, Draycott-place of the flat front without balconies, the Wycliffe and Welbeck mansions are specimens of modern residential flats without shops under, while Symons-street close at hand affords a curious collection of cottages, small old houses and courts, two of which have their gardens. [The demolition of these last has commenced within the last few days.]

Viewing the rebuilding of London from a sanitary point of view, the greater attention paid to stables and stable-yards cannot be overlooked. In many cases attention is paid to their architecture, and the dwelling-rooms, instead of being little better than lofts—"good enough for outdoor servants"—are such as to induce the occupiers to take a pride in keeping them in good condition; while the yards are so paved and supplied with water that they can be easily kept clean.

It is curious to note how the building of villa residences with gardens has at different times shifted from one district to another. While rows of houses were being built in the Regent's-park district villas were being erected in the Brixton district. The greatest activity in villa building has lately been at "South Hampstead," while rows of houses and no villas have been put up, or, as it is frequently said, "run up," in the Brixton, Camberwell, and Stockwell districts.

The land belonging to Dulwich College is gradually being covered by detached and semi-detached villas, mostly only one storey high, built of red brick, in a modification of Tudor style, with gardens attached. The old timber on the estate is saved as far as practicable, and trees are planted in the newly-formed roads. The general effect of the new "village," as it is called, is admitted to be pleasing.

Whether there will again occur such a congestion of population at particular spots in London is a question upon which opinions vary, as already the population that have had to move in consequence of changes are congregating in certain parts of the 'outer ring," and not spreading equally—*e.g.*, Battersea is already recognised as a new "East-end."

WATER SUPPLY OF ITALIAN TOWNS.

In the inquiry on the sanitary condition of all the Italian towns and villages instituted in 1885, the following data, according to the *Reichsanzeiger* (Berlin), were abtained with regard to the supply of drinking water. In 2,491 communes, with 6,196,584 inhabitants, only spring water was consumed; 1,583 communes, with 5,267,744 inhabitants, had only well water; 1,732 (5,965,703 inhabitants) spring and well water, and 130 (721,893 inhabitants) only water collected in cisterns for consumption. In 1,321 communes, with 7,026,229 inhabitants, cistern water in combination with spring and well water was drunk, whilst 946 communes, with 3,201,803 inhabitants, drew their drinking water exclusively or chiefly from rivers, and 55 communes, with 79,154 inhabitants, from lakes. Spring water is consumed principally by the populations of Liguria, Latium, the Abruzzi, the Basilicata, Calabria, Sicily, and Sardinia; well water preponderates in Piedmont, Lombardy, and Emilia; cisterns are found most frequently in Tuscany, the Mark, Emilia, Campania, Apulia, and Sicily; river water meets with the largest consumption in Venetia, and by the population living near to the mountains of Piedmont, Liguria, and Tuscany; lake water is drunk near the large lakes of North Italy. In 2,720 communes drinking water is brought longer or shorter distances in metal or wooden pipes, or in conduits constructed of masonry, cement, or clay; in 447 communes the supply is simply through open channels. In 614 communes lead pipes are used in taking drinking water to towns and houses. In 6,763 Italian communes, with a population of 22,434,735 persons, the required drinking water is supplied in sufficient quantities; in 1,495 communes, with 6,024,375 inhabitants, the quantity furnished is insufficient. Regarding quality, it is stated that, with a sufficient supply of drinking water, 81·8 per cent. of the communes have good, 13·1 per cent. medium, and 5·1 per cent. bad water; in the case of the communes with insufficient supply, the proportions are 56·3, 25·5, and 18·2 per cent.—*Builder.*

SOUTH AFRICAN FOOD-PLANTS.

The Zulus cultivate maize (*muhindi*), from which, mixed with *pombe* beer, excellent loaves are made. Millett (*mtama*), especially of the red sort, and another grain called *mawele* or *mwere*, and esteemed by the natives, but too heating for Europeans, are also grown. Two kinds of cereal are indigenous to the Okovango country. One is a sort of Kaffir corn with flattened, roundish seed of a reddish-yellow colour, which has been named *Holcus Suluani*, though probably only a variety of *H. sorghum*; this is principally used for the preparation of malt liquor. A second kind, much more highly prized for food, is very small in the grain, resembling canary seed, and is called *omahange*. Both are very prolific, yielding about 2,000-fold. In addition to grain, two kinds of bean are cultivated, one brown and the other white, each very palatable, and the latter quite a delicacy, yet neither esteemed by the natives, who much prefer corn. The farinaceous dishes prepared

by the natives from these materials, a sort of porridge called *umtshobila*, lack flavour, which is often contributed in the form of a stewed rat.

Carelessness in neglecting to grow sufficient corn compels the people in most seasons, for about two months before the harvest, to have recourse to wild fruits, roots, and other chance supplies of edible products. Sometimes they live principally on manioc or cassava, which they eat both boiled and roasted. For summer use, when the root is apt to be watery and inferior, they break it up and dry it in the sun. In this state, when raw, it tastes like arrowroot biscuit, and when pounded into flour, it makes a good sort of bread, and is, in fact, the only native production that is sufficiently glutinous to form bread in our sense of the word. The pounding is usually effected by means of huge wooden pestles and mortars, or stones; but Hlengas perform the operation in holes in the ground, artificially plastered and hardened with ant-hill earth, which apparently contains so much lime as to form a perfect cement. In these holes, with pestles of African iron-wood (*umsimbiti*), which may be *Olea capensis*, or *Sideroxylon capense*, they produce fine meal without contaminating it with grit. The root of an evergreen shrub (*umtshungutsi*) when thus pounded into coarse meal, is largely eaten, and from it is also manufactured a drink tasting like sugared water.

In Umzila occurs a gigantic creeper, bearings pods as large as a boy's head, striped with broad bands of white and green, containing flat "nuts" the size of a florin; these seeds are highly oleaginous, and are eaten by the natives. A rich, dark-foliaged and dark-stemmed tree produces a small yellow acorn-looking (minus the cup) fruit, which is much prized by the natives, but rather too sweet and insipid for the European palate. The fruit of wild fig-trees is plentiful, but not very well flavoured.

Among the evergreens on the Limpopo there grows a cherry-like fruit called *inhlanspha*, which falls when ripe; it has a sweet, mealy taste, and contains two long seeds. The natives collect these, squeeze out the seeds, dry the fruits in the sun, and then pound the fleshy part into meal, which is made into a very palatable porridge or drink. As the fruit whilst drying gets fly-blown, it is about as full of maggots as rice soup is of rice. The skins of the uncooked fruit eaten in any quantity cause violent attacks of windy colic; on cooking the fruit in ashes, and rejecting the skins, no ill results follow. Another fruit, also found along the rivers, growing on a large tree, called *umtorma*, is also eaten, and is very refreshing, tasting like fruit jelly. During the season of these fruits the natives eat nothing else, so as to save their corn. People living away from the rivers come great distances to collect these fruits.

The natives exhibit much skill in converting grain and fruits into beverages of a more or less seductive character. This is the end served by the saccharine cane (*sorghum*) which they cultivate. Also of a luscious fruit called *cazu*. Then *umgoza*, affording a kind of canary seed, though tastless and indigestible as grain, is made into a most intoxicating beer, one variety of which is named *outchuala*. The grain is roasted before grinding it into meal, and makes a deep, red coloured porridge. Formerly, the Tongas grew it solely for fermenting, but Zulu aggression has driven them to grow it for bread, its inferiority placing it beyond the risk of being stolen.

There is a huge-stemmed, wide-spreading tree with small elongated leaves, which yields in ordinary years tons of a small apple-looking fruit, containing a strong kernel surrounded by a fleshy pulp which adheres most tenaciously. After removal of the skin this pulp has an agreeably sweet-acidulous flavour As the fruit begins to ripen it falls to the ground, whence it is carefully gathered by the natives, who convert it into a kind of wine. This is done by simply removing the rind, and then throwing the fruit into a vessel partially filled with water. In a day or two it is fit for use.

A creeper called *umtshanjowa*, whose greenish-white flowers load the air with a most delightful perfume, produces a sweet and agreeable fruit, growing in bunches of red berries, from which the natives make a very palatable wine of a deep, rich, red colour.

The rubber vine, with very rough, warty bark, and a very few small round leaves at the extremities of the uppermost branches, produces a fruit about the size of a lemon, mottled with green and white when immature, and yellow when ripe, which has a pleasant acid flavour. The natives make a palatable fermented drink from it, slightly acid, but very refreshing on a hot day, called *imbunga*. The fruit of the waterboom serves a similar purpose.

The ordinary Kaffir beer, a fermented decoction of the meal of the *mabele*, or red variety of *Holcus sorghum*, is called *tyuala*. A fermented drink known as *buchem* is made from the juice of the vegetable ivory palm (*lala*). In extracting this juice, the natives first prepare a number of gourds, generally the shell of a species of *nux vomica*, called *umkwakwa*, but often those of the baobab fruit. Then they make a sort of conical cap of plaited palm leaves, and sallying forth to their grounds, cut the leaves and young stems from the stalk, and sharpen the latter to a point. They next make a channel in the wood, stick in a bit of the stiff leaf as a sort of spout for the juice to drip off by, hang the gourds over the head like a necklace, and cover the top with the conical cap. The drink thus prepared is cool and palatable, resembling newly-made ginger beer. When in the proper state of fermentation it has the same biting taste as champagne.

The leaves of several plants are collected and infused for the preparation of a series of so-called "teas" (the *thee* of the Dutch colonists), which are drunk as substitutes for the well-known dietetic beverage commonly indicated by that name. The following kinds are recognised:—

1. *Stekel-thee.*—This is a decoction of the leaves of

Borbonia parviflora, some other species possibly being sometimes included. It possesses diuretic properties.

2. *Doorn-thee*, having emollient and expectorant qualities, is made from the leaves of *Cliffortia ilicifolia*.

3. *Kaffir-thee* is a demulcent drink, good in pulmonary complaints, prepared from the leaves of *Helichrysum nudiflorum*, a common herbaceous plant.

4. *Hottentot-thee* resembles the last named; it has an agreeable aroma, and is appreciated by the natives. It is afforded by *Helichrysum serpyllifolium*.

5. *Duinen-thee*, likewise drunk for coughs and chest diseases, is an infusion of the leaves of *Helichrysum auriculatum*.

6. *Boschjesmans-thee*, a favourite drink among the Bushmen, besides having a beneficial effect on coughs and asthma, is derived from an amyridaceous shrub, *Methyscophyllum glaucum*.

7. *Honig-thee* consists of the dried stalks and leaves of the shrub *Cyclopia genistoides*; it has a pleasant aromatic odour, and an agreeable astringent flavour.

8. *Busch-thee* is apparently derived from the leaflets of *Cyclopia brachypoda*.

9. *Cap-thee* may probably be ascribed to *Cyclopia longifolia* or *C. galeoides*.

No alkaloid corresponding with thein or caffein has yet been discovered in any of these leaves.

The tubers of two kinds of sedge, *Cyperus rotundus* and *C. esculentus*, are used for food in Damara Land and elsewhere.

PAINTING ON CEMENT.

According to the *Bulletin de la Ceramique*, it is known that the caustic lime which is not in a state of combination in cement saponifies the oil used in painting. Consequently painting on cement is only practicable when, under the influence of the air, carbonic acid has united with the caustic lime to form carbonate of lime. When it is desired to paint cement without delay, attempts are sometimes made to neutralise the lime by acids; but the above-named journal recommends in preference the use of carbonate of ammonia, the acid of which combines with the lime while the acid is liberated. The effect produced is, however, only superficial. Various other expedients are referred to, but the solution of the problem would seem to consist in the use of caseine. Fresh white cheese and slaked fat lime are added to the colour. This mixture hardens rapidly, assumes the consistency of stone, and is insoluble in water, a formation of albuminate of lime taking place. It is according to this system that the mural paintings at the Berlin War Museum were executed.

To make the composition, three parts of cheese and one of slaked fat lime are stirred, the quantity of colour to be added being regulated by practice. Only earth colours or oxides of iron would be used for light red to dark brown shades; for blue, ultramarine or cobalt blue would be used; for white, oxide of zinc or sulphate of baryta; and for black, animal black. Inorganic colours, such as those of aniline, would not be used, nor would Prussian blue, vermilion, blue ochre, and white lead be employed, on account of the injurious effects of the sulphur present in the cheese in combination with these substances.

If the painting surface is too dry it can easily be damped. The caseous lime should be prepared daily, and the brushes should be cleaned after the application of each coat of paint. The process thus described is recommended for its economy, the walls of a house being painted as fast as the scaffolding is removed. The caseous paint does not easily take fire, and is therefore considered particularly suitable for the decoration of theatres, and for application to stage carpenter's work generally.

SIBERIAN EXHIBITION.

The number of the *Journal de St. Pétersbourg* of the 21st inst., containing an article on the commercial future of Siberia, in connection with a notice of the Exhibition held this summer at Ekaterinberg, has been received from the Foreign Office. It is said that the products of Siberia are but poorly represented in the Exhibition, and that it was found difficult to induce the Siberian producers to exhibit at all, and when they did so the products were not always of the best quality. The leather manufacture is well developed, and it is said that the first place in production belongs to the Kolmagorow manufactory, which prepares annually 100,000 skins, for the sum of 600,000 roubles, which are sent to St. Petersburg, Moscow, China, and the Kirghiz steppes.

The writer in the *Journal de St. Pétersbourg* says that the Exhibition was full of interesting products, but that it was not thoronghly representative. He adds that although this is quite comprehensible in view of the enormous distances to be traversed, and the insufficiency of the roads and modes of conveyance, it is to be regretted that visitors were only able to obtain an incomplete and inexact idea of the real productive power of Siberia. It is the opinion of M. Rostchensky, Director of the Ekaterinberg branch of the Volga-Kama Bank, that with more attention to the organisation of the country, and development of the means of communication, Russian Asia would be able to supply products valued at hundreds of millions of roubles.

The following Table contains particulars obtained from M. Rostchensky:—

Annual Exportation of Siberia.

	In Summer. Puds.	In Winter. Puds.
Butter	50,000	200,000
Fish	—	500,000
Linseed and hempseed oils	20,000	—
Tallow	200,000	700,000
Honey and wax	25,000	50,000
Corn	1,500,000	—
Meal	500,000	—
Linseed	—	300,000
Cedron nuts	100,000	300,000
Sheeps' hides	60,000	100,000
Glue	30,000	—
Feathers and hair	30,000	—
Copper and tin	80,000	10,000
Wool and camel's hair	100,000	15,000
Silver and gold	3,000	6,000
Ivory	3,000	2,000
Potash	—	180,000
Tea	400,000	500,000
	3,201,000	2,963,000

Making a total of 6,164,000 puds, one pud being equal to a little over 36 lbs. Siberia is said to furnish Russia annually with products valued at 100 million roubles.

Complaint is also made with respect to the poorness of the section of Siberian animals and live stock, as shown at the Exhibition of Ekaterinberg.

Notes on Books.

Merchandise Marks Act, 1887. By Newnham Browne. London.

Mr. Newnham Browne has issued in pamphlet form an edition of the Merchandise Marks Act passed in the last Session, with a few notes and some memoranda on the registration of trade marks. This Act makes many important alterations in the existing law, and affects many practices which, until the passing of the Act, were in common use. Penalties are inflicted for false description as to quality, quantity, place of manufacture, material, maker's name, &c. It is, therefore, obviously important for manufacturers and traders to make themselves familiar with the provisions of the Act as it now stands.

The Pattern-maker's Handybook. By Paul N. Hasluck. London: Crosby Lockwood. 1887.

This is one of the series of "Handy Books for Handicrafts" by the same author. It contains a good deal of information as to the various devices adopted in making patterns for casting, and there is also some information as to the processes of moulding and founding, probably as much as will be required to be known by the pattern-maker. A good deal of the information relates to wood-turning generally, and appears to be of much the same character as that contained in other works by the same author. The book is illustrated with cuts of the chucks, tools, and machines generally employed, and of typical patterns and portions of patterns.

Handbook for Steam Users. By M. Powis Bale. London: Longmans, 1887.

This small volume is an enlargement of a chart of rules for engine-drivers published some years ago by the author, and intended to be hung up in engine-rooms. The first chapter consists of rules for engine-drivers and boiler attendants, the second and third deal with the management of steam engines and boilers, while the fourth is devoted to the explosion of steam boilers, giving an account of the usual causes of explosions, and of the methods adopted for their prevention.

The British Roll of Honour; a descriptive account of the recognised orders of chivalry in various countries and their origin, also detailed lists of the British subjects now living who have been enrolled in these orders. By Peter Lund Simmonds, F.L.S. London: Dean and Son.

This volume of nearly six hundred pages is divided into two parts. The first contains an account of the various orders, with lists of those belonging to them, and is illustrated with coloured plates of the decorations. The second is an alphabetical list of British subjects holding English or foreign decorations, in which these honours are fully set out. Mr. Simmonds points out in his preface that the number of persons connected with the British knightly orders is under three thousand, and that nearly half of these are devoted to the military and naval professions. The numbers are as follows:—

Orders of the Garter, Thistle and St. Patrick	63
Order of the Bath	2,018
Order of St. Michael and St. George	460
Order of the Star of India	246
Order of the Indian Empire	202
	2,989

The number of these honours which are possessed by soldiers and sailors is 1,459. Mr. Simmonds does not give the number of the foreign decorations conferred upon Englishmen, but they are considerable, the list of the officers of the Legion of Honour being the largest.

The Architect's Register. Vol. 2. London: W. Pope. Sm. 8vo.

This is the second half-yearly volume of a book of reference intended for the use of architects and

builders. It contains six papers read before the Architectural Association, viz., "House Sanitation," by Dr. Corfield; "The Architecture of Art," by Walter Crane; "Welsh Churches," by A. Baker; "Architect and Contractor," by H. Lovegrove; "Stray Thoughts in Architectural Education," by J. Aitchison; and "Notes on Gloucestershire," by R. W. Paul. Besides these six papers there are three lectures, delivered at Carpenters'-hall, in connection with building.

UNIVERSAL PHONOGRAPHY: an attempt to select and classify the principal sounds of human speech, and to denote them by one set of symbols for easy writing and purity; with an Appendix on the use of Phonography for the Blind. By William Benson. London: Chapman and Hall, 1887.

Mr. Benson, realising how impossible it is to represent the sounds of human speech in any completeness by the ordinary letters, has superseded these entirely by a new set of characters, and he fortifies his opinion of the necessity for a new notation by quoting the utterances of many of our foremost phonologists. At the same time he points out that, if not adopted generally, his system can be used with advantage by those who are engaged in the transliteration of words and in the publication of works in languages that have no letters of their own, and also that it might be of special use in printing for the use of the blind.

Obituary.

MR. J. T. WOOD.—James Templeton Wood, M.A., who was elected a member of the Society of Arts in 1862, died at his house in Pembridge-gardens on Wednesday, the 19th inst., in the 68th year of his age. Mr. Wood was for some years Secretary of the Eastern Bengal Railway, and took an active part in its administration. Losing his sight while out shooting, he was compelled to retire from his office, but he continued to take a lively interest in Indian railway subjects. He was an assiduous member of the Indian Section of the Society, and of the Sectional Committee, and he frequently spoke at the evening meetings.

General Notes.

STEAM-ENGINES.—According to the Berlin Bureau of Statistics there are in the world the equivalent of 46,000,000 horse-power in steam-engines, 3,000,000 being in locomotives. In engines other than locomotives the United States comes first with 7,500,000 horse-power; England next, with 7,000,000 horse-power; Germany, 4,500,000 horse-power; France, 3,000,000 horse-power; and Austria, 1,500,000. Four-fifths of the steam-engines now in operation are said to have been built within the last twenty-five years.

FOREIGN MEAT SUPPLY.—We imported last year 302,681 tons of meat, made up as follows:—806,867 cwt. of fresh beef, and 190,723 cwt, of salted beef, 3,264,795 cwt. of bacon, and 946,034 of hams; 371,696 cwt. of fresh and salted pork, 432,000 cwt. of preserved meats, and 41,528 cwt. of salted or fresh undefined meat; the total value of which was £21,728,125. This was exclusive of live animals, lard, rabbits, poultry and game, eggs and dairy produce, fish, &c., to about an equal value. The total sum paid for these articles of food being £43,290,264.

COPENHAGEN EXHIBITION.—It is proposed to hold a Scandinavian Exhibition at Copenhagen next spring. There is to be a complete display of Danish products and manufactures, and Norway will be fully represented; but it is said that Sweden has not yet decided to take part officially in the Exhibition.

BOLOGNA EXHIBITION.—At the International Exhibition to be held at Bologna in May next, in commemoration of the fifth centenary of the foundation of the University, it is said that music will form an important feature. Signor Verdi is the honorary, and Signor Arrigo Boito the acting president of the committee nominated for the collection and arrangement of rare instruments, interesting autographs, and other objects bearing upon the history of music. An English branch committee has been formed in London for the same purpose, and Mr. G. W. Cusins, Master of the Queen's Music, has undertaken to act as chairman.

MUNICH EXHIBITION.—The Bavarian Association of Industrial Art has (according to the *Sprechsaal*) organised an Exhibion to be held at Munich from May to October, 1888; the principal object of which is to display the progress made during the last twelve years by German industrial art. The development of art in Germany will be represented from an historical point of view by the fitting up of a series of rooms in the styles of the principal artistic epochs; these apartments being fitly devoted to the reception of specimens of the older styles of German industrial art. Modern works are to be grouped according to national and corporate associations. German, Austrian, and Swiss artists have been invited to exhibit. Arrangements are being made for the decorative treatment of the rooms at the cost of the exhibitors, but where collective exhibits are organised the exhibitors will be allowed to carry out the decorative work in conjunction with the directors of the enterprise. The question of awards and distinctions will be treated by a Commission representing the various countries taking part in the display.

CORRECTION.—Page 979, col. 2, line 19, for 4,500 *read* 4,500,000.

Journal of the Society of Arts.

No. 1,824. Vol. XXXV.

FRIDAY, NOVEMBER 4, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

IMPERIAL INSTITUTE.

The Council announce that, in accordance with the desire of H.R.H. the President (as expressed in the letter of Sir Frederick Abel, see *ante* p. 971), they propose to keep open the subscription list to the Imperial Institute, for the purpose of obtaining subscriptions to the Endowment Fund. Subscriptions should be sent to the Secretary (H. Trueman Wood), Society of Arts, John-street, Adelphi.

PRIZES FOR ART-WORKMEN.

Prizes are offered to art-workmen under the following eight classes:—

1. Painted glass, £25, £15, £10.
2. Glass blowing in the Venetian style, £10, £5, £3.
3. Enamelled jewellers' work, £25, £15, £10.
4. Inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10.
5. Lacquer, applied to the decoration of furniture or small objects, £25, £15, £10.
6. Decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10.
7. Hand-tooled bookbinding, £25, £15, £10.
8. Repoussé and chased work in any metal, £25, £15, £10.

All articles for competition must be sent in to the Society's House, on or before Saturday, 3rd December, 1887, and must be delivered free of all charges.

A full statement of the conditions under which these prizes are offered was given in the number of the *Journal* for September 16th last, and can be obtained on application to the Secretary.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-fourth Session of the Society will be held on Wednesday, the 16th November, when the Opening Address will be delivered by Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 23.—"The Mercurial Air-pump." By Prof. Silvanus P. Thompson.

November 30.—"Economical Illumination from Waste Oils." By J. B. Hannay.

December 7.—"The Chemistry, Commerce, and Uses of Eggs of various kinds." By P. L. Simmonds.

December 14.—"Commercial Education." By Sir Philip Magnus.

Papers for which no dates have as yet been fixed:—

"Technical Instruction in Agriculture." By Prof. John Wrightson.

"Machine Tools for Boot and Shoe Manufacture." By John W. Urquhart.

"Framework Knitting." By W. T. Rowlett.

"Locks and Safes." By Samuel Chatwood.

"Telescopes for Stellar Photography." By Sir Howard Grubb, F.R.S.

"The Measurement of Electricity." By Prof. George Forbes, F.R.S.

"The Continuation of Elementary Education." By W. Lant Carpenter, B.A., B.Sc.

"Type-writers and Type-writing." By John Harrison.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 17; February 7; March 6, 27; April 17; May 15.

Indian Section.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—

January 27; February 10, 24; March 16; April 13; May 4.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 31; February 14; March 20; April 24; May 8, 29.

CANTOR LECTURES.

The First Course will be on "The Elements of Architectural Design." By H. H. STATHAM. Four Lectures.

November 28; December 5, 12, 17.

The Second Course will be on "Yeast, its Morphology and Culture." By A. GORDON SALAMON. Four Lectures.

January 30; February 6, 13, 20.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By JOHN MAYALL, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor CHANDLER ROBERTS-AUSTEN, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply, and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.

April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.

April 30; May 7, 14.

JUVENILE LECTURES.

Two Juvenile Lectures on "The Application of Electricity to Lighting and Working," by WILLIAM HENRY PREECE, F.R.S., will be given on Wednesday evenings, January 4 and 11, 1888, at Seven o'clock.

Miscellaneous.

WARSAW EXHIBITION.

Mr. Henry Grant, her Majesty's Consul at Warsaw, has forwarded a memorandum to the Foreign-office on the Exhibition of Textile Goods and Machinery to be held at Warsaw about the middle of December next, which will be open to all conntries. Mr. Grant suggests that the Exhibition might afford a good opportunity of increasing the importation of British textile goods and machinery into Poland, and adds that the articles which are specially suited for this market are:—Cotton yarns and threads of high numbers, cambric, serge, Irish light linen, Scotch tweeds and fancy cloths, silk stuffs and dyes, beltings, and all kinds of textile machinery.

The following classification of the goods to be exhibited has been published by the Warsaw Branch of the Russian Society for the Encouragement of Trade and Industry, under whose patronage the Exhibition will be held:—

Section I.—Cotton.

Section II.—Flax, hemp, jute, and other vegetable fibres.

Section III.—Wool.

Section IV.—Woollen and half-woollen tissues.

Section V.—Hosiery and tricots.

Section VI.—All kinds of haberdasheries, carpets, felt, ribbons, laces, and embroideries.

Section VII.— Silk. (Cocoons, raw and spun cheppe and silk, silk tissues, foulards, ribbons, chenille, velvet, and plush.)

Section VIII.—Tissues partially mixed with india-rubber, elastics, india-rubber ribbons, window blinds, oil-cloth.

Section IX.—Beltings of flax, hemp, camel hair, cotton, &c., tapes, lamp wicks, sugar bags, packing linen, ropes and string.

Section X.—Chemicals and dyes for dyeing, bleaching, printing, and finishing textile fabrics; samples of dyed raw wool or cotton, &c.; samples of yarns and cloths of all kinds, dyed, bleached, printed, and finished.

Section XI.—Textile machinery. In this section only models or machines can be accepted that require little space, such as sewing and knitting machines. Plans and sketches and description of textile machinery will be accepted for exhibition, and advertisements of machinery manufacturers are solicited for insertion in the catalogue of the Exhibition.

Section XII.—Publications in connection with textile industries; sanitary rules for mills and works; rules and plans of institutions founded for the benefit of the working classes, such as schools, hospitals, asylums, funds for invalid and sick workmen, savings banks, &c.

The offices are—Faubourg de Cracovie, and the forwarding agent, Maurice Luxemburg, Warsaw.

DIAMOND CUTTING INDUSTRY.

The *Statist* contains an article on this industry (which, some 200 years ago, was forced away from our own shores), with the object of awakening Englishmen to its value, and the importance of re-establishing it in this country:—

"It has been from official sources ascertained that the rough stones exported from the Cape during the four years 1883-6 weighed no less than ten and a

quarter millions of carats, valued at eleven and a half millions sterling, but no reliable data can be obtained prior to September, 1882. Of course no accurate estimate can be made of diamonds taken away on the person or stolen or smuggled away. Further, it is estimated that 33 millions of carats, realising upwards of 40 millions sterling, had been extracted from the mines of Kimberley, De Beer, Bultfontein, and Dutoitspan collectively up to the end of 1886.

"The diamond cutting industry in Amsterdam, which employs in all some 10,000 persons, appears to have been in a state of transition for some years past, and it is a fact that much of the capital employed in this lucrative enterprise is controlled by London and Paris houses. The original system, by which the owners of the so-called diamond cutting mills in Holland simply provided the motive power, lighting, and necessary space at fixed rates to contracting cutters, seems to be gradually giving way to the establishment of large diamond cutting works, employing regular cutters, who are paid wages according to their capability. The number of mills in existence in the Dutch capital cannot be less than 6,000 to 8,000. Not only is this number rapidly increasing, but the cutting industry has extended from Amsterdam to Antwerp, to Hanau, near Frankfort—where the diamond cutting and polishing is almost exclusively for London account—and even to Switzerlaland.

"It would be difficult, in fact, impossible, to give anything approaching to correct statistics of the quantity of diamonds passing through the Amsterdam mills, owing to the special character of the trade, and the fact that the stones, both rough and cut, are carried backwards and forwards between Amsterdam and the markets on the persons of the dealers, thus escaping observations of the State authorities, but also from the number of private cutters engaged in the business. The best judges, however, estimate that about 20,000 carats of rough diamonds are weekly manipulated by the Amsterdam craftsmen.

"As regards wages, it is not easy to give any absolute figures which would serve as a basis, nearly all the work being done by the 'piece,' the price of which varies with its nature and the size and value of the stones; hence the tariff has a very wide range. A skilled cleaver and polisher can almost command his own price. In the large establishments which employ cutters the wages paid are about as follows: —Women and girls for rose cutting, 25s. to 35s. per week; cutters, 35s. to 75s. per week; cleavers, 50s. to 130s. per week; polishers, 40s. to 120s. per week, working twelve hours daily.

"There is no doubt that some of the skilled and private workmen can and do earn more than the maximum figures. These workmen under the old system have to pay for space and motive power about 2s. to 2s. 6d. per day of twelve hours—the weekly rental of about 15s. per mill, showing a profit of about 50 per cent., after deduction of expenses and interest on capital.

"The earnings of workmen employed in the Amsterdam trade are gradually decreasing, and probably will continue to do so, as the new system of large works conducted on wages payments, and with powerful mechanical appliances, develops. Hence, even if skilled English workmanship were not immediately procurable here, there would be little, if any, difficulty in inducing Amsterdam diamond workers to come to London at about the same rate of wages as hitherto paid them in Holland. The poorer Jews, who are so largely engaged in this industry, are nomadic, fond of change, and soon make themselves at home in their new surroundings; moreover, the surplus labour will, ere long, make itself felt in the Dutch capital."

After giving these particulars, the writer in the *Statist* adds :—

"There is no presumption in stating that this art would be capable of employing thousands of artisans, both male and female, and distributing in wages an amount which would reach annually, at least, half a million sterling. There are in our midst skilful and competent Englishmen, able and willing, if only properly backed up and encouraged, to implant anew in this country, and to direct with intelligence and entire success, this most lucrative business. There can be no question of our ability to erect and equip workshops equal, if not superior, to anything to be found in Holland or elsewhere, and to carry on operations at a reduced cost. The trade admits that factories solely laid out for cutting, and capable of turning out workmanship of the highest excellence, would receive hearty support, and that if such were efficiently organised they would undoubtedly be successful. Under these circumstances, it certainly appears desirable that the trade should foster any movement which may have for its object the restoring of the lost art to its ancient stronghold, and of making world-wide the fact that British workmanship is equal to-day to any that can be procured abroad. The time has arrived for action, the field of operations is open, and the demand is greater than the supply."

THE IVORY TRADE OF THE EAST COAST OF AFRICA.

A correspondent of *Das Handels-Museum* of Vienna says that for centuries Zanzibar was the chief mart of ivory, which was formerly brought partly from the coast, partly from the interior. But with the increased consumption and value of that article, elephants are being exterminated, and have to be sought far away in the interior, to the west of Tanganyika, and north-west of Victoria Nyanza. The chief trading centre in the interior is Tabara, in Myamwesi, where various caravan routes meet The practice, at present, is for Indian traders to equip a caravan in Zanzibar, and place it in charge

of an experienced and trustworthy Arab, who takes it from Bagamoyo, opposite Zanzibar, to Tabara. If he finds enough there he exchanges goods which he has brought for the purpose, and starts on the return journey; but, as a rule, the caravan has to go further, and by the information he receives from returning caravans the conductor judges where he can go with most chance of speedy success. Large quantities of ivory are usually in the hands of native chiefs, with whom it is a kind of treasure, and sometimes, it is said, the Arab conductors will make war on a chief, seize his ivory, and sell his people into slavery. If force cannot be used, the trader must patiently purchase small quantities from time to time, as occasion arises, and sometimes he is forced to wait for years in the interior before he can part with all his merchandise and obtain his loads of ivory. The greater part of the ivory arrives in Zanzibar in July and August; the Indian merchants go to Bagamoyo to meet their conductors, and then a settlement takes place. The cost of the caravan, with 15 per cent. per annum, is charged to the Arab, the Indian takes the ivory, sells it on account of the Arab, and pays the latter the balance. Arrived in Zanzibar, the ivory is either sent by the Indian merchants direct to Bombay, or to London, or it is sold to Hamburg or American merchants on the spot. The trade, therefore, is wholly in the hands of Indian merchants; but the advantage of having agents of the European merchants in Tabara to purchase ivory systematically, and forward it to the coast, has been discussed in Zanzibar, and one Hamburg firm there decided to try it. A caravan under two Germans was despatched to Tabara, where one was to remain to establish a branch, while the other pushed on to Uganda, so as to be able to purchase at first hand. One died soon afterwards, and the other fell ill and was forced to return. The close connection between the ivory and the slave trade in the interior must always act as a hindrance to Europeans trading at first hand in ivory. The Arabs usually transport the ivory to the coast by means of natives whom they have enslaved or purchased at very low prices, and then can sell the latter on the coast at a profit of $10 a head. European traders, on the other hand, must pay the bearers $5 a month and an arm's length of cotton stuff per day. No statistics exist respecting the annual exports from Zanzibar, but the writer is convinced that for ten years past it has been pretty regular. In the past 35 years the price has trebled. About 1840, ivory $1 a pound; now it costs $3. Large tusks, weighing 150 lb. to 190 lb., are much rarer than they were ten years since, and the number of smaller tusks has greatly increased. Zanzibar ivory stands higher in the market than that from Abyssinia, Egypt, or the West Coast. The export from Mozambique and the north and south Somali coasts is comparatively small. The best ivory is used for the manufacture of billiard balls; the inferior sorts are converted into knife handles, ornaments, &c.

CANADIAN FRUIT SUPPLY.

The *Bulletin of the Royal Gardens, Kew*, for November, contains information obtained in answer to inquiry respecting Colonial fruit, made by Mr. D. Morris, assistant director, through the Colonial-office. A list is given of the varieties of apples, pears, plums, cherries, peaches, grapes, gooseberries, currants, raspberries, and strawberries, and such wild fruits as the blueberry, the saskatoon berry, and the cranberry as are grown in Canada.

The exports of fresh fruits for the year ending on the 30th June, 1886, were as follows:—Apples to Great Britain, 176,505 barrels, value $410,898; to the United States, 41,407 barrels, value $55,302; to other countries, 4,831 barrels, value $10,804. Other fruits were exported of the following value:—To Great Britain, $38; to the United States, $22,064; to other countries, $492.

It is stated that all the fruits mentioned are capable of being produced in much larger quantities than at present, indeed there is no practical limit to the capacity of Canada for the production of fruit. A very large number of young orchard trees are being planted annually, which will shortly result in a greatly increased yield. The experience gained during the recent Colonial and Indian Exhibition in London has shown the importance of cold storage in the transportation of fruit, especially of the early ripening sorts, and it is highly desirable that facilities in this direction should be offered to the fruit growers of Canada, so as to stimulate the export of autumn fruits.

The Government of Canada are establishing in most of the larger provinces experimental farms, where many experiments in fruit production will be carried on, new and promising fruits introduced from all parts of the world with the view of enlarging the area of fruit culture and increasing production. With suitable information given as to the most profitable sorts to grow, and the excellent facilities now provided for rapid transport, it is believed that the energy of Canadian fruit growers will furnish all the other stimulus needed to enlarge and extend this important branch of agricultural industry, and, with reasonable facilities, furnish supplies for all the markets which may be open to them.

The imports of fruits into Canada (such as might in large proportion be grown there) for the year ended June 30th, 1886, were as follows:—Apples from the United States, 31,575 barrels, value $63,775; small fruits, viz., blackberries, gooseberries, raspberries, and strawberries, from the United States, 231,378 lbs., value $23,557; cherries and currants, from the United States, 51,085 quarts, value $4,914; cranberries, plums, and quinces, from the United States, 17,170 bushels, value $34,650; from Newfoundland, 15 bushels, value $13; grapes from the United States, 389,868 lbs., value $27,340; peaches from the United States, 592,880 lbs., value $42,571.

Canned fruits from Great Britain, 1,512 lbs., value $149; from the United States, 592,391 lbs., value $34,495.

With regard to the above figures, it should be borne in mind that a large proportion of the green or fresh fruits imported into Canada from the United States consists of early ripening sorts, which are obtainable from the southern portions of that Republic several weeks in advance of Canadian fruits, and are in demand chiefly among those classes of the community who can afford to pay for such luxuries out of season.

IRON MINES OF BILBOA.

The United States' Consular Agent at Urraza says that the number of iron mines in the province of Bilboa is about three hundred, and they are situated in the mining districts of Somorrostro, Galdames Arcentales, Sopuerto, Regato, Abando, Ollargan, Galdacano, and Guernica. The greater part of these mines have been known for centuries, but up to the year 1851 they were only worked for the smithies in Vizcaya, which used solely the class of minerals known as *vena dulce*, the consumption of which, up to that year, did not exceed 40,000 tons per annum, the value of which, delivered at the mine, was about two shillings per ton. The ores are classified as *vena campanil*, *rubio* and *calon*, the yield of which in metallic iron is estimated at 58, 52, 50, and 43 per cent. respectively. All these are free from phosphorus and sulphur, and it is stated that it is for this reason that they owe in a great measure their acceptance in foreign markets. The largest exportation of ore was in the year 1882, when 3,692,000 tons were shipped for foreign countries, and 44,000 tons for Spain, or altogether 3,736,000 tons. The whole process of taking out the ore is open to the sky, as in a quarry, so that the work of extracting the mineral is reduced to cleaning it from the vegetable earth, and from the rock and sand, and afterwards of blowing up enormous masses of mineral, sometimes exceeding 2,000 tons in weight, by dynamite, and then breaking up these large blocks to the ordinary small size by the use of common powder. The cost of the dynamite, powder, and fuses is calculated to be about fourpence per ton of mineral produced. The total cost of a ton of clean mineral at the mouth of the mine varies from two shillings to two shillings and sixpence. In the extraction, cleaning, and carrying the mineral, about 8,000 workmen are engaged, who gain on an average about two shillings and sixpence per day. The work of extraction is at the present time almost exclusively limited to the mines in the districts of Somorrostro, Galdames, Regato, Abando, and Ollargan, which from their proximity to the river and port of Bilboa, permit of the mineral being loaded with greater economy than from the other districts. The transport is effected by means of pack-horses and mules, bullock-carts, aërial wire tramways, floating chains, automatic inclined planes, and four railways terminating at the river of Bilboa, one at the bay of Porina, and another which starts from the Esperanza mine and terminates at the deposits of Ortuella, where is situated the upper station of the railway of the Provincial Deputation, traversing part of the Triano Mountains. The transport by pack animals and bullock-carts exists from various mines to the above railways, a distance of from one to three kilometres, there being employed in this service about two hundred horses and five hundred bullock-carts, the cost per ton being estimated at about two shillings. The aërial tramways and inclined planes are also used, for the greater part for the carriage of the mineral from the mines to the railways. The five railways used for the carriage of the mineral from the mines to the loading places are—the railway of the deputation which starts from the foot of the Triano Mountains, and terminates at the river of Bilboa at El Desierto; the railway of the Urconera Company extending from Gallarto to the river of Bilboa at Luchana; the railway of the Franco-Belge Company, which starts from Granada and ends at Luchana; the railway of Galdames, extending from the Berango mine to a place called Serlas, near the mouth of the Bilboa river; and the railway of Messrs. Maclennan, which starts from the mine San Julian de Muzquiz, and terminates at Poveña.

WEST AFRICAN DRUGS.

There can exist no doubt of the remarkable medicinal value of many vegetable products of West Africa, known to and appreciated by the natives, but not yet familiarised in Europe.

In Lower Guinea, the rhizome of a papyrus (*Cyperus articulatus*) is used for allaying intestinal pains, and is cultivated to some extent for that purpose; in Ashanti, it is employed as an anthelmintic. Another species (*C. hylæus*) is also esteemed. African peach root (*Sarcocephalus esculentus*) is a fine bitter tonic, extensively prescribed for indigestion. Termite earth is applied to ulcers, boils, and gangrenous wounds, and has been tried with success in London hospitals. The young shoots of a plant called *oro*, grown for hedges, and probably either a cactus or a euphorbia, act as an irritant poison; and from a dried extract of the juice the natives prepare a powerful purgative called *agoomoo*. Erysipelas is combated by fomentations with an infusion of the leaves of the plant *Tiaridium* (*Heliotropium*) *indicum*, or application of the bruised fresh leaves. The plant called *kakeis* (*Oldenlandia globosa*) possesses properties somewhat resembling ipecacuanha, and is given in dysentery. The "male" plants of the the fern (*Polypodium phymatodes* are used in kid-

ney complaints; and the female fern is valued by the women. A substitute for cream of tartar, as a diuretic and alterative, is found in *Osbeckia rotundifolia* (*Dissotis plumosa*). The purgative properties of the physic nut (*Curcas purgans*) are known and utilised; while the oily secretion of the pericarp of *Anacardium occidentale* is applied as a caustic to warts.

The common remedy for fevers of all kinds is an infusion of the leaves of a shrubby plant, *Ocymum viride*. Hæmorrhage, even when arteries are severed, is most effectually stopped by an application of the pounded leaves and flowers of *Aspilia latifolia*, while a decoction is valuable in pulmonary bleeding; the action may be mechanical, as with matico, or due to an inherent power of coagulating the fibrin of the blood, as with *Jatropha Curcas*. The leaves of "small senna" (*Cassia occidentalis*) are used as a purgative. A decoction of *pipybras* (*Scoparia dulcis*) is prescribed in gravel and kidney diseases. Sassy bark, from a large and common tree called *mançône* or *bourane* (*Erythrophleum guineense*), affords a powerful poison with which arrows are anointed; its action is on the heart, which it soon arrests. The dreaded ordeal poison of the Gaboon, called *icaja*, is furnished by the bark of a shrub named *mboundou*, *mbondon*, or *bondon* (*Strychnos sp.*); the action bears some resemblance to that of strychnine, being extremely rapid, but soon eliminated, while artificial respiration many often prevent fatal results. The seeds of the *inée* or *onaye* (*Strophantus hispidus*) afford another powerful cardiac poison. Poisonous drugs are also produced from the *ilango*, an orchidaceous plant; from the *atchimé*, an *Ignatia sp.*; from the "Calabar leaves" (*Physostigma venenosum*); from *okanyago*; and from *ourendé*.

A valuable bitter, possessing febrifuge qualities, and even suggested as a local equivalent for quinine, is afforded by the bark of the *doundaké*, *doy*, or *amelliki* tree (*Sarcocephalus esculentus*), which has been utilised by the native negroes for ages. In Sierra Leone the people call the fruit of this plant the "peach" or "fig" of the country; it is sold in the markets, and may be compared with a strawberry, though the odour is rather that of an apple. Eaten in excess it acts as an emetic. The bark is often mixed with that of one or more species of *Morinda*.

Probably the most important drug in native estimation is the *kola* nut, called also *colat*, *khola*, *cula*, *gura*, and *gouroo*, and afforded by a wild tree, *Cola acuminata* (*Sterculia tomentosa*). This nut forms a universal tonic or narcotic, apparently combining the good effects of both. It is chewed by the natives of the whole of Western, Central, and Northern Africa as regularly and uniformly as tea or coffee is taken in England, and forms one of the most important articles of intertribal trade. The use of the drug is said to give strength, allay inordinate appetite, assuage thirst, promote digestion, and increase the powers of endurance. The nuts are also employed as a means of rendering bad water fit for drinking. They contain 2 per cent. of theine, and a small quantity of volatile oil, which probably adds to their value. The tree, called *muxixes* or *mukazo* in Angola, is widely distributed in Tropical Africa.

Excellent tobacco grows in a wild state in the Cameroons country, and there is no doubt this plant would repay systematic cultivation; but the lazy natives neglect the local growth, and import manufactured tobacco for their own wants.

NATIVE SHEEP OF SOUTH AMERICA.

Consul Baker, of Buenos Ayres, in his last report, says that at the time the Spaniards first visited South America there were no animals in the country which exactly corresponded to the sheep of Europe, but they found in Peru, and in the regions of the Andes, several species of animals to which they gave the name of native sheep (*carneros de la tierra*), but which the aborigines called the llama, the alpaca, the guanaco, and the vicuña. The two first-named varieties were even then nowhere to be seen in a wild state, but were domestic animals in the service of the natives. While there is a general similarity between these several classes, yet each one seems to form a distinct genus. The llama and the alpaca are of various colours, and sometimes speckled. The guanaco and the vicuña are generally of a single colour—brown, approaching to red. The llama and the alpaca are said to be so resigned to their state of domesticity that they are scarcely able to take care of themselves or live in a wild state. The guanaco and the vicuña prefer the wild state. Although these animals are all indigenous to the Cordilleras of the Andes, none of them are found north of Ecuador, neither in Quito, Bogota, nor Caracas, where the climate is similar to that of Peru or the Argentine Republic. The guanacos are especially found in the extreme south western portions of the province of Buenos Ayres, and in the desert ranges of Patagonia, as far south as the Straits of Mayellan. There they are the principal food of the Indians, their skins being used for clothing and for coverings for their wigwams. The Chilians and the Auricanian Indians also have an animal which they call the *chilihueque*, which is supposed to be the alpaca of Peru, modified by the climate, and which they formerly used as a beast of burden, but the use of which has, in a great measure, been superseded by the introduction of mules. Of the several varieties of native sheep, the largest and strongest is the llama. It was especially esteemed by the native inhabitants as a beast of burden. Its load is about 100 lbs., although for short distances it is able to carry considerably more. Its height is from four to five feet, and the length of its body is about the same. It has no horns or hump, and its hoofs are cloven. Its body is shaped like

that of the deer, with clean, slender legs, its cloven hoofs ending in talons or claws, like those of a bird of prey. Under its breast there is a hard substance about six inches long and three inches wide, on which it sleeps or rests. The llama is covered with a very fine silky hair or wool, which is not shed like that of the camel, but when properly cared for grows to a length of from three to four inches. The finest is on its legs. The animal rarely produces more than one young at a time, the period of gestation being six months, and it comes to maturity at three years of age. The Indians are very fond of the meat, esteeming it beyond that of any other animal; they dry it in quantities, and they regard the soup made from it as a sovereign remedy in nearly all cases of sickness. At ordinary labour the llama will last for twelve years, but those which are used in the mines do not live longer than three or four years, in consequence of infirmity caused by the sulphurous exhalations. The size of the alpaca is a little less than that of the llama, its height being about four feet, the length of its body being the same, and its appearance when the fleece has been removed is very similar to that of the llama. Its hind legs are shorter than its fore ones, and are somewhat curved, and its hoofs are cloven, but the claws are very small. It drinks very little, but has a voracious appetite. When used as a beast of burden it is capable of carrying from seventy-five to a hundred pounds, but not on long journeys. It is on account of its fleece that the alpaca is most esteemed, and this makes it the most valuable of the South American native sheep. The wool is long, soft, and abundant, being double the amount which the other varieties afford. On its side, breast, and back, its fleece is from 8 to 16 inches long. It is of various colours, and sometimes speckled. Outside the wool, and sometimes protecting it, is a long hair, which is exceedingly fine, so that the fleece is really a combination of hair and wool. It is sheared by the Indians twice a year—in June and December. The guanaco is from 3½ to 4 ft. in length, by about 4½ ft. in height, and except in a few rare cases it is always found in the wild state. It is always of the same colour—a brownish red, and in its general appearance resembles the llama, the chief difference being a greater curvature of the back, a more shaggy fleece, and smaller feet. The guanaco is the fleetest animal which South America produces, and it is so courageous that when surrounded by the hunters it will turn upon them, and trample them under foot. It is generally seen in droves or flocks of from 200 to 300. The guanacos are vigilant, and exceedingly circumspect in their movements, and when feeding they place one of their number as a sentinel, to announce the arrival of an enemy. The flocks which are now to be seen on the frontiers have generally a large excess of males, for the reason that, being stronger and swifter of foot than the females, they more readily escape the toils of the hunters. The vicuña is the smallest and most delicately formed of all the native sheep, but its wool is the finest, and on that account it is the most interesting, and the most highly prized. Its height is only about 3½ ft., and its length about 2½ ft. It only weighs from 75 lbs. to 100 lbs., while the llama weighs 250 lbs. In its general form and appearance it corresponds to the other varieties. Its head is erect, and is covered with wool of a reddish colour, which is also the colour of the fleece. Its wool is the finest, the softest, and the most silky, that is known, and when it has been cleared of the hair that grows with it, it is regarded as the most valuable in the world. The wool on the back is without any mixture of hair, while on the rest of the body it is even larger than the wool—thus somewhat protecting it. The wool on the belly is white. The vicuña is gregarious, and inhabits the snowy peaks of the Andes, and the flocks are frequently mixed with those of the guanaco. They are very timid, and difficult to secure, but it is estimated that about 250,000 vicuñas are still annually hunted down. Consul Baker says that only a small quantity of wool of any of these animals is shipped from the country; the exact amount, however, cannot be known—for the reason that the exports of wool are not classified by the authorities. The greater portion is consumed in the country, and is used by the inhabitants of the interior in the manufacture of yarns, threads, and a variety of woollen textures. The best of the native fabrics are made in Catamarca, and some of the other upper provinces, but not in sufficient quantities to meet the demand. The principal merit of the native shawls, pouches, &c., is that they are entirely impervious to water, at the same time that they are light and fine, and they readily command high places, ranging from one to five hundred dollars, according to their finish, but it takes, says Consul Baker, many months of hard work to complete the fabrics.

SUGAR PRODUCTION IN HAWAII.

The climate and soil of Hawaii are, according to Consul-General Putnam, of Honolulu, peculiarly adapted to the production of sugar, as the sugar cane has continuous summer, so that a single crop can have from sixteen to twenty months, the time usually occupied to complete its growth. Sugar is the great staple of the country, and immense capital and energy, and great intelligence, have been expended upon the industry. The result is an increase in the yield from 12,000 tons in 1875, to an estimated yield of 75,000 to 80,000 tons in 1885. There are 75,000 acres of land possible for cultivation of the cane. The planters in Hawaii have two methods of producing sugar cane, viz., where they depend upon the natural rainfall, and where they resort to irrigation. In the first case the practice is to suitably prepare the land by ploughing and harrowing until it is entirely free from weeds, grass, &c.,

and then to plant the joints of cane in furrows or lines in such quantities and at such distances as experience may dictate. Each joint of the sugar cane produces one leaf, and one bud or eye. The leaf grows out of the joint itself, or the junction of the joints, and completely envelopes the stalk, covering and protecting the bud or eye. The buds when covered with earth send out shoots or stalks, and are the means of propagation, no seeds being known. The buds come out alternately on opposite sides, and the opening of the leaf is opposite the bud it covers, so that the bud when young and tender is perfectly protected by its leaf. When the joint is planted it is stripped of its leaves, and where the leaf had been previously attached the roots spring out. Then the bud or eye, if healthy, sends out its shoot, with joints and eyes in their turn, and each eye that remains under ground reproduces itself. The best cane for planting is that which has the shortest joints. The length of joints, or distance between the joints proper, varies from or two to ten or twelve inches. Long-jointed cane is considered best for grinding. The cultivation of the cane stalks simply requires the weeds and grasses to be kept down, and the soil loose and mellow. This is done by means of small ploughs and cultivators drawn by one horse or a mule, and, in some cases, by hoeing. As the cane grows and forms stalks, it sends forth leaves as above described, these perform their office, and then wither and die, from the bottom upwards, and good cultivation requires that they shall be removed, or stripped from the stalk, to admit air and light—both necessary to the proper maturing of the cane. This is generally done two or three times in a season. Although there are different kinds of cane, flowering and non-flowering, most of the cane used in Hawaii flowers in the month of November. After flowering, it stops growing, the top dies, and it sends out side shoots from the eyes near the upper joint, and as this is detrimental to its sugar-producing qualities, the canes have to be cut as soon as convenient after the flowering season. Having no frost in Hawaii (at low altitudes) the young cane that does not flower continues to grow all the year through, and on this account planters are able to produce large crops to the acre by having long seasons of growth—occasionally from sixteen to twenty months, but the cost of cultivation is considerably greater. When the cane is matured, it is cut by means of hatchets or knives, near the bottom, if possible, just under the ground, and the stalks, stripped of their leaves and worthless tops, are conveyed to the mill for grinding. The cane is delivered on the cane carrier of the three-roller mill, and, with the assistance of two men to feed, it passes through the rollers of the same under heavy pressure, and the juice—to the extent of from 50 to 65 per cent.—is extracted. The cane residuum, or *bagasse*, is passed through a second mill, where from 10 to 15 per cent. more juice is extracted. This is called double crushing, and if water is used on the *bagasse* before the second grinding, it is called maceration. As the juice is extracted, it is pumped through the heaters into the clarifiers, or large iron tanks, with copper or brass steam coils, in which the juice is heated to a temperature of 200° to 210°, and lime is added to correct the acidity, and aid in defecation. The juice is afterwards thoroughly cleaned by means of heat, and the water evaporated from it until the concentrated liquor stands at about 26° to 30° Baumé, when it is ready for the vacuum pan. The work of the vacuum pan is to take in a certain quantity of this concentrated liquor at a temperature not above 150° Fahrenheit, and to boil it down to what is known as the striking point, that is about 40° Baumé. When the sugar boiler considers that he has obtained the right quantity and density, he admits a charge of cold liquor, which has the effect of separating the small particles of saccharine or crystallisable sugar, and is called "starting the grain." After proper boiling or concentration, another charge of cold liquor is taken into the pan, and the effect is to build up or enlarge the grain so started, and the operation is continued until the vacuum pan is sufficiently filled with sugar of the required grain. Closing in, or finishing the strike, consists of boiling the mass to such state or consistency as is best for drying, and the vacuum is then broken, and the whole mass discharged into a receiver or mixer ready for the dryers. The drying is done by centrifugal motion, which separates the molasses by whirling them through fine wire cloth or screens, and leaving the dry sugar in walls on the inside. The dry sugar is then put in bags or other receptacles, ready for the market; while the molasses are reboiled in the vacuum pan, and made into sugar of lower grade.

INDIGO TRADE IN SAN SALVADOR.

The quantity of indigo produced annually in San Salvador varies from 9,000 to 15,000 bales of 150 lbs. each. Unlike most other products of the country, only one crop is produced each year, and a smaller second crop from the same seeding. Indigo seeds, Consul Dupré says in his last report, are sown broadcast, like wheat and oats, and ploughed in. Every seed germinates twice, and thus there are two annual crops. Prices fluctuate greatly in San Salvador, and without apparent cause, and the natives are capricious in their demands and fancies. The crop, as prepared for market, is graded like cotton and wheat in the United States, and the numbers "6," "7," "8" and "9" on the bales define the class or grade to which the bale belongs. The last of the figures designates the best, and the first the lowest grade. The absolute cost of production is about two shillings and eightpence a pound, while in India the cost is stated to be about one shilling. In San Salvador the indigo is cut with *machetes* instead of reapers. It is very much like oats in the fields, and this method of mowing is both tedious and laborious.

When cut, the indigo is soaked in vats, "puddled," boiled, strained and dried, and this is all done by the simplest means, and all by manual labour. The natives convey the indigo to the market towns in packs on their backs. Samples are spread on mats, beside which the farmer sits awaiting customers, and these are attracted from all lands by the annually recurring indigo fairs of Salvador. These market periods in each city commonly last from eight to fifteen days. The special saint of each of these indigo markets is specially invoked during the continuance of the sales, and thus the priests and churches share in the profits incidental to these gatherings of the people. The first great indigo fair of the year begins on the 30th August at Santa Rosa, the next when the first closes, at Chalatenango, the next at Sesuntepeque, and then follow those, attended by vast numbers of people, at San Miguel, near the harbour of La Union, which begins on the 17th and last until the 25th of November. Consul Dupré adds, in conclusion, that formerly consumers of indigo in the United States bought and imported their supplies from India through Liverpool or London, but they now buy largely from Salvador, and instead of four or five hundred bales, as in former years, sent to the United States, it is expected that one-sixth of the whole crop of 1887 will be taken by New York and Boston, and by cotton mill owners of the south. There is an export duty on indigo in Salvador amounting to about fourteen shillings per bale.

Correspondence.

BREAD REFORM.

Miss YATES, Hon. Sec. of the Bread and Food Reform League, writes:—

"As numerous complaints have been received about the variable quality of whole and wheat-meal bread, will you kindly allow me to state that bakers inform me that this can be obviated by mixing the yeast with cold water, about 66° Fah., instead of using the tepid water generally employed. Mr. J. E. Thausing states in 'The Theory and Practice of the Preparation of Malt,' that experience shows that fermentation carried out at a high temperature tends to develop acetic acid, lactic acid, and butyric acid fermentations, whereas fermentation at a low temperature does not do so. As wheat-meal ferments very rapidly, the high temperature usually employed by bakers is probably the reason that wheat-meal bread, especially in hot weather, is very liable to become sour. The bread should also be baked in a cooler oven than is used for white bread, or under a tin, as a high temperature causes wheat-meal bread to have a disagreeably hard crust. Attention to these details will facilitate the manufacture of a palatable and digestible wheat-meal bread, the general adoption of which will greatly promote the health of all classes of society."

General Notes.

BUTTERINE.—The quantity of butterine imported last year was 887,000 cwt., of the value of £2,962,264 The bulk of it was received from Holland, and about 21,000 cwt. each from Norway and Belgium.

VIENNA EXHIBITION.—An Industrial Exhibition will be held at Vienna in 1888, to celebrate the fortieth anniversary of the accession of the Emperor to the throne. It is proposed to publish in connection with the exhibition statistics showing the improvement in the social position of the industrial population which has taken place during these forty years.

ELECTRIC LAUNCH.—Trials have been made at Havre with an electric launch built to the order of the French Government by the Forges et Chantiers de la Mediterranée. The vessel, which has rather full lines, measures 28 ft. between perpendiculars, and 9 ft. beam, and is five tons register. The electro-motor is the invention of Captain Krebs and of M de Zédé, naval architect. The propeller shaft is not directly coupled with the spindle of the motor, but is geared to it by spur-wheels in the ratio of 1 to 3, in order to allow of the employment of a light high-speed motor. The latter makes 850 revolutions per minute, and develops 12-h.p. when driving the screw at 280 revolutions. Current is supplied by a new type of accumulators made by Messrs. Commelin and Desmazures. One hundred and thirty-two of these accumulators are fitted in the bottom of the boat the total weight being about two tons. The result of the trials gave a speed of 6½ knots during five hours with 12-h.p., and sufficient charge was left in the accumulators to allow the boat to travel on the following day for four hours.

OIL LAMPS AT EAST MOLESEY.—The lighting committee of East Molesey recently presented the following report, which has been adopted:—"Your committee, in presenting their second annual report on the subject of lighting lamps with oil, have pleasure to inform you that it has been a great success, and given general satisfaction. Fifteen new lamps have been erected during the year in various parts of the parish, much to the comfort of the parishioners, and for which they have expressed their thanks. We have now 127 lamps burning from sunset to sunrise. The illuminating power is much greater than we ever had when burning gas; the lights are steady and bright even on the stormiest and coldest nights. We are agreeably surprised to find that the cost for the year is only £289 13s. 7d., being

at the rate of £2 5s. 7d. per lamp, which amount, if compared with the cost of gas, viz., £4 4s. per lamp, will show a saving of £244 14s. 5d. to the parish, being equal to a 2½d. rate. We have also to record that a saving of £20 has been effected in the purchase of lamp-posts and lamps in comparison with what the gas company charge."

SHELLAC.—The *Strohhut Zeitung* quotes a short description of the above substance. It is a resin obtained from gum-lac, which is very brittle at a cold temperature, and is moderately hard, being, moreover, free from taste and smell. It melts under the influence of heat, this being even partially the case on the homeward journey from India; the so-called blocky shellac being thus produced. When heated it gives off an odour of a not unpleasant character, and burns with a bright flame. It is insoluble in spirit of wine, borax, and carbonate alkalies. In addition to its well-known use in connection with the hat trade, it is employed in the preparation of varnish, &c. In commerce it is an important speculative article, the fluctuations to which it is subject being attributed to this circumstance. India is the source of supply. Until about 10 or 15 years ago the trade was concentrated in London, Hamburg and Bremen only sharing to a moderate extent in the imports, the quantity of which has increased from 20,000 cases in 1860, to about 65,000 or 70,000 cases at the present time. Since the opening of the Suez Canal the supplies of Southern Europe and Austria have been received through Trieste and Genoa. When prices have been high, the question of manufacturing shellac in Europe has been discussed, but it has been found that the production of the gum-lac, from which it is prepared, is so dependent upon the climatic conditions existing in India, that the scheme has never assumed a practical form.

TECHNICAL INSTRUCTION IN CARRIAGE BUILDING.—The Council of the Institute of British Carriage Manufacturers has approved and issued to its members a syllabus of instruction for young men preparing to engage in carriage manufacture. This syllabus includes lists of subjects suitable for employers, for managers and foremen, for accountants, clerks, &c., and for skilled artisans. The subjects of general education required for the foremen include reading, writing, arithmetic, drawing, mechanics, metallurgy, book-keeping, geography, and one foreign language. The accountant classes are expected, in addition to these, to have a knowledge of commercial law, shorthand, type-writing, the arrangements necessary in the packing and shipment of carriages. No technical instruction is set down for them. Rather higher general education is required from managers and foremen, while the syllabus for employers includes also elementary engineering, elements of botany and forestry, animal and vegetable substances used in the manufacture, contrast and harmony of colours, &c. The technical subjects required from the artisans depend upon the class of work on which they are engaged, varying according as the artisans are workers in wood, smiths, painters, or trimmers. The technical education for employers includes the principles of designing and constructing carriages in whole or in part, mechanics, knowledge of qualities and characters of woods, and a knowledge of the varieties of carriages used in the different parts of the world.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 7...Chemical Industry (London Section) Burlington-house, W., 8 p.m. 1. Mr. C. T. Kingzett, "Note on the Comparative Antiseptic Action of Chlorides, Nitrates, and Sulphates." 2. Discussion on Mr. John Ruffle's paper, "The Correct Analysis of Superphosphates, Plain and Ammoniated."

British Architects, 9, Conduit-street, W., 8 p.m. Opening Meeting. President's Address.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. P. F. Nursey, "Primary Batteries for Illuminating Purposes."

TUESDAY, Nov. 8...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Address by the President, Mr. George B. Bruce. Presentation of medals and prizes.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Exhibition of Implements and Works of Art from the Lower Congo. By Major-General Sir Frederick Goldsmid and Mr. Delmar Morgan. 2. Mr. R. C. Phillips, "The Lower Congo: a Sociological Study."

Colonial Institute, Whitehall Rooms, Hôtel Métropole, Whitehall-place, S.W., 8 p.m. Rev. Canon Dalton, "The Colonial Conference of 1887."

WEDNESDAY, Nov. 9...Geological, Burlington-house, W., 8 p.m. 1. Mr. Henry B. Brady, "Note on the so-called 'Soapstone' of Fiji." 2. Prof T. G. Bonney, "Some Results of Pressure and of Intrusive Granite in Stratified Palæozoic Rocks near Morlaix, in Brittany." 3. Prof. T. G. Bonney, "The Obermittweide Conglomerate, its Composition and Alteration." 4. Prof. T. G. Bonney, "Notes on a Part of the Huronian Series in the neighbourhood of Sudbury, Canada." 4. Prof. T. McKenny Hughes, "The Position of the Obermittweide Conglomerate."

Microscopical, King's College, W.C., 8 p.m. 1. Mr. H. B. Brady, "Synopsis of the British Recent Foraminifera." 2. Mr. C. R. Beaumont, "Metamorphoses of Amoebæ and Actinophrys."

THURSDAY, Nov. 10...Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Edward Stallibrass, "Deep-Sea Sounding in connection with Submarine Telegraphy."

FRIDAY, Nov. 11...Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, Nov. 12...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Dr. R. C. Shettle, "The Rotation of a Solid Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field." 2. Mr. T. H. Blakesley, "A Geometrical Method of determining the conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents."

Journal of the Society of Arts.

No. 1,825. Vol. XXXV.

FRIDAY, NOVEMBER 11, 1887.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NOTICES.

DR. MANN LECTURES.

The Council have received from Mrs. Mann, the widow of the late Dr. R. J. Mann, a gift of twenty pounds, to defray the cost of two lectures on the "Protection of Buildings from Lightning," the lectures to be given as a memorial of the late Dr. Mann, and to be called the *Dr. Mann Lectures.* The Council have had much pleasure in accepting the offer, and have succeeded in obtaining the services of Professor Oliver J. Lodge for the delivery of the lectures. The dates on which they will be given will be hereafter announced.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Thirty-fourth Session of the Society will be held on Wednesday, the 16th November, when the Opening Address will be delivered by Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 23.—"The Mercurial Air-pump." By Prof. Silvanus P. Thompson.

November 30.—"Economical Illumination from Waste Oils." By J. B. Hannay.

December 7.—"The Chemistry, Commerce, and Uses of Eggs of various kinds." By P. L. Simmonds.

December 14.—"Commercial Education." By Sir Philip Magnus.

Papers for which no dates have as yet been fixed:—

"Technical Instruction in Agriculture." By Prof. John Wrightson.

"Machine Tools for Boot and Shoe Manufacture." By John W. Urquhart.

"Framework Knitting." By W. T. Rowlett.

"Locks and Safes." By Samuel Chatwood.

"Telescopes for Stellar Photography." By Sir Howard Grubb, F.R.S.

"The Measurement of Electricity." By Prof. George Forbes, F.R.S.

"The Continuation of Elementary Education." By W. Lant Carpenter, B.A., B.Sc.

"Type-writers and Type-writing." By John Harrison.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 17; February 7; March 6, 27; April 17; May 15.

Indian Section.

The meetings of this Section will take place on the following Friday evenings, at Eight o'clock:—

January 27; February 10, 24; March 16; April 13; May 4.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday evenings, at Eight o'clock:—

January 31; February 14; March 20; April 24; May 8, 29.

Cantor Lectures.

The First Course will be on "The Elements of Architectural Design." By H. H. Statham. Four Lectures.

November 28; December 5, 12, 17.

The Second Course will be on "Yeast, its Morphology and Culture." By A. Gordon Salamon. Four Lectures.

January 30; February 6, 13, 20.

The Third Course will be on "The Modern Microscope." (Being a continuation of the recent course of Cantor Lectures on the "Microscope.") By John Mayall, Jun. Two Lectures.

February 27; March 5.

The Fourth Course will be on "Alloys." By Professor Chandler Roberts-Austen, F.R.S. Three Lectures.

March 12, 19, 26.

The Fifth Course will be on "Milk Supply,

and Butter and Cheese-making." By RICHARD BANNISTER. Three Lectures.
April 9, 16, 23.

The Sixth and Concluding Course will be on "The Decoration and Illustration of Books." By WALTER CRANE. Three Lectures.
April 30; May 7, 14.

JUVENILE LECTURES.

Two Juvenile Lectures on "The Application of Electricity to Lighting and Working," by WILLIAM HENRY PREECE, F.R.S., will be given on Wednesday evenings, January 4 and 11, 1888, at Seven o'clock.

Miscellaneous.

SILK ASSOCIATION.

A conference was held in the Royal Jubilee Exhibition, at Manchester, on Friday, October 21st, under the auspices of the Silk Section Committee, and with the support of the Chairman and Executive Committee of the Exhibition, which was attended by nett silk manufacturers, throwsters, raw and waste silk dealers, merchants, spinners, dyers, and finishers of the country, with the intention of considering how the silk industry of Great Britain and Ireland could be best revived and maintained.

Mr. Thomas Wardle, in his address as chairman, pointed out that in the decade 1854 to 1863 our imports of manufactured silk goods from the Continent amounted annually to £3,373,233, whilst in the decade 1874 to 1883 they had increased to an annual average of £11,831,057. In 1855 we purchased £1,826,525. In 1880, just twenty-five years afterwards, this sum had grown to the prodigious amount of £13,085,083, an increase of £11,258,588. Since 1880, and up to last year, our imports of manufactured silks from the Continent had averaged about eleven millions sterling a year. He said, further, that the trade had not even a journal, whilst France had four, and not only so, but she possessed two societies for promoting silk culture and industry—the Soie Lyonnaise and Laboratoire d'études Sericoles de la Condition des Soies de Lyon, whilst all her societies of agriculture paid special attention to questions relating to silk, and there were practical French scientists employed experimentally with sericulture, who made public from time to time the results of their researches. He could not close without alluding to the extensive raw silk producing power of India and our colonies. The area over which raw silk could there be cultivated was far greater than that for cotton. India alone was richer than any other part of the world in her different and interesting species of silk.

Several papers were then read, and at the close of the meeting the following resolutions were passed:—It was proposed by Mr. Wardle, and seconded by Sir Joseph Lee, and carried, "That a national committee be appointed from this meeting to form an institute or association of persons engaged in the silk industry, either as manufacturers, merchants, or retailers, and to draw up provisional rules for the same. The committee to be formed from the Silk Section Committee, with power to add to their number."

It was also resolved, "That a memorial be sent from this meeting to the Government urging them to carry out the recommendation of the last meeting of the Associated Chambers of Commerce held at Exeter—that a Minister of Commerce and Agriculture be appointed."

"That a memorial be sent from this meeting to the Government, reeommending that the Technical Instruction Act, which was dropped in the last session, be carried in the next session."

"That Government be recommended to compel all manufacturers of home and foreign silk goods to declare them, and, if adulterated, the amount of adulteration to be specified to the distributors and the public."

A meeting is to be held to-day (Friday, Nov. 11th), in the Mayor's Parlour, Town-hall, Manchester, when the following matters will be considered:—Appointment of president and secretary, title of association, places of meeting, amount of subscription, publication of proceedings of first conference, organisation of a silk journal.

Notes on Books.

MANUALS OF COMMERCE: TECHNICAL, INDUSTRIAL, AND COMMERCIAL. By John Yeats, LL.D. Vol. I. The Natural History of the Raw Materials of Commerce. Vol. II. The Technical History of Commerce; or, the Progress of the Useful Arts. Vol. III. The Growth and Vicissitudes of Commerce. Vol. IV. Recent and Existing Commerce. London: George Philip & Son, 32, Fleet-street.

The first of these volumes treats of each substance wherever it originates above ground or beneath the surface; shows what is done with it to make it useful; and indicates where it is bought, sold, or largely consumed. The products are classified under the mineral, vegetable, and animal kingdoms, and scientific terms are attached for wider reference. The practice of the arts forms the subject of the second volume, which does more than record the

economic progress, by furnishing material standards of comparison between nations, and beyond that, enables persons mentally to estimate results. The study is interesting, inasmuch as it proves how very far back in the past extend the roots of those growths of national greatness, the number of which constitutes the glory of the nineteenth century. The third volume is devoted to the growth and vicissitudes of commerce. The principle underlying commerce is shown to be reciprocal service. Without interchange division of labour could not continue, and the arts of civilised life would be lost. Trade involves distribution as well as production. The vicissitudes of commerce are roughly indicated in an historical chart which accompanies the maps. One State after another has obtained the lead and lost it. Of the six that belonged to antiquity only three are of any significance now; of the nine originating in the middle ages only three again remain. The fourth volume contains a brief review of British industry and trade, a survey of our colonial and foreign relations, a retrospect of the commercial policy of 1840-1887, and a section on the national divisions of commerce. These are based upon similarity of produce, and seasons of shipment; and set forth within well-known geographical limits or trade areas. There are natural zones of needs as of supplies. This volume further contains a list of upwards of one thousand centres of industry and trade, with all the most prominent products of each, its imports, its currency, its nearest seaport, its internal means of communication by railway or canal, and its approximate distance from London. It has also supplementary tables, which show at a glance the share obtained by the United Kingdom in the commerce of other countries, with per-centages of the rise or fall of our trade in every great market. The volume, as a whole, seems intended to be a picture of universal industry, in which the most important factors are selected as objects for study and comparison. In a certain sense the world's labour is shown territorially—that is, each part on its own soil—and yet in the proportions due to cosmopolitan interests or international relations.

General Notes.

Village Technical Teaching in Ireland.—The method of village technical teaching described in the paper read before the Society of Arts, in May last, by Mrs. Ernest Hart, having been approved by the Government, and a small grant of £1,000 having been made for the extension of technical teaching by the Donegal Industrial Fund, 43, Wigmore-street, in the arts of weaving, dyeing, &c., the Earl of Leitrim, the Catholic Archbishop of Armagh, Mr. Moray Ward, Mr. Woodall, M.P., technical school commissioner, and Mr. and Mrs. Ernest Hart are acting as a committee to administer the fund. At a public meeting held last week at Milford, the Earl of Leitrim in the chair, the methods of teaching were explained, and the results hitherto attained were demonstrated. Resolutions were passed inviting Mrs. Hart to form new teaching centres at Carrygart, Rosnakill, Kilmacrennan, Rathmullen, and Milford. Subsequently steps were taken for complying with the request forthwith. The Protestant and Catholic clergy of the districts, and the leading traders of all denominations, took part in the meeting, and a unanimous opinion was expressed of the undoubted needs of the district, and of the value of the work, which all present joined in pledging themselves by resolution to support.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 14...Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. J. M'Carthy, "Explorations in Siam."

Tuesday, Nov. 15...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Sir Frederick Abel, "Accidents in Mines." (Part II.)

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. A. Boulenger, "Reptiles and Batrachians collected by Mr. H. H. Johnston" 2. Mr. Edgar A. Smith, "Shells from the Rio del Rey, Cameroons." 3. Mr. A. G. Butler, "African Lepidoptera." 4. Mr. G. A. Boulenger, "A new Species of Hyla."

Wednesday, Nov. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the 134th Session. Address by Sir Douglas Galton, Chairman of Council.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. F. W. Corry, "The Use of the Spectroscope as an Hygrometer." 2. Mr. John G. Gamble, "Rainfall on and around Table Mountain, Capetown." Dr. Robert Lawson, "Diurnal Oscillation of the Barometer."

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Report on Compulsory Working of Patents. 2. Mr. J. C. Mewburn, "Whether Nonconformity between the Provisional and Complete Specifications invalidates a Patent."

Thursday, Nov. 17...Linnean, Burlington-house, W., 8 p.m. 1. Mr. P. Geddes, "Variation in Plants and Animals." 2. Mr. T. C. Thompson, "Copepoda of the Canaries."

Chemical, Burlington-house, W., 8 p.m. 1. Election of Fellows. 2. Mr. C. M. Stuart, "The Halogen substituted Derivatives of Benzalmalonic Acid."

Parkes Museum of Hygiene, 74A, Margaret-street, W., 5 p.m. The Ear lof Meath, "The Importance of Open Spaces."

Historical, 11, Chandos-street, W., 8½ p.m. Mr. Oscar Browning, "Nootka Sound and Reichenbach."

Friday, Nov. 18...Civil Engineers, 25, Great George-street, S.W., 7 p.m. (Students' Meeting.) Mr. John Holliday, "Boiler Experiments and Fuel Economy."

Philological, University College, W.C., 8 p.m. Mr. Whitley Stokes, "Neuter Stems in S in the Celtic Languages."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year.

TRANSACTIONS, &c.

American Academy of Arts and Sciences, Proceedings and Memoirs.
American Philosophical Society, Transactions.
American Society of Civil Engineers, Transactions.
Association of Engineering Societies, Journal.
Bath and West of England Society, Journal.
Bayerische Dampfkessel-Revisions-Verein, Bayerisches Industrie-und-Gewerbeblatt.
Berlin, Polytechnische Gesellschaft, Verhandlungen
Birmingham Philosophical Society, Proceedings.
British Association for the Advancement of Science, Report.
British Horological Institute, Journal.
Camera Club, Proceedings.
Camera di Commercio Italiana in Londra, Giornale.
Chemical Society, Journal.
Chemico-Agricultural Society of Ulster, Journal.
Cleveland Institution of Engineers, Proceedings.
Doubs, Société d'Emulation du, Memoires.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Gas Institute, Transactions.
Geological Society, Quarterly Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Proceedings.
India, Geological Survey of, Memoirs, Records, and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institute of Patent Agents, Transactions.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Kew Gardens Bulletin.
Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
Liverpool Polytechnic Society, Journal.
London Chamber of Commerce, The Chamber of Commerce Journal.
Lyons, Société des Sciences Industrielles, Annales.
Manchester Literary and Philosophical Society, Memoirs.
Manitoba Historical and Scientific Society, Transactions.
Mauritius, Société Royale des Arts et des Sciences, Transactions.
National Indian Association, "The Indian Magazine."
Pharmaceutical Society, Journal and Transactions.
Philadelphia, Academy of Natural Sciences, Proceedings.
Philadelphia, Engineers Club of, Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Rome, Giornale del Genio Civile.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Report.
Royal Geographical Society, Proceedings and Journal.
Royal Geological Society of Ireland, Journal.
Royal Institute of British Architects, Journal of Proceedings and Transactions.
Royal Institution, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Internationale des Electriciens ,Bulletin.
Société Nationale d'Acclimatation de France, Bulletin Mensuel.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Transactions and Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Telegraph Engineers and of Electricians Journal.

South Wales Institute of Engineers, Proceedings.
Victoria Institute, Journal of the Transactions.
Vienna, Orientalische Museum, Das Handels' Museum.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.
Commissioners' of Patents Journal.

Weekly.

Admiralty and Horse Guards Gazette.
Amateur Photographer.
American Architect and Building News.
American Manufacturer and Iron World.
Architect.
Athenæum.
Avenir.
Bradstreet's.
British Architect.
British Journal of Photography.
British and Colonial Druggist.
Builder.
Builders' Weekly Reporter.
Building News.
Chemical News.
Colliery Guardian.
Colonies and India.
Cosmos ; Revue des Sciences.
Country Brewers' Gazette.
Electrician.
Electricité.
Empire.
Engineer.
Engineering.
Engineering and Builders' Record (New York).
English Mechanic.
European Mail.
Farmer and the Chamber of Agriculture Journal.
Gardeners' Chronicle.
Gardening World.
Gas and Water Review.
Gas World.
Herapath's Railway Journal.
Indian Engineering.
Industries.
Invention.
Iron.
Iron and Coal Trades Review.
Iron and Steel Trades' Journal.
Ironmonger.
Jewelers' Weekly (New York).
Journal of Gas Lighting.
Journal d'Hygiène.
Land and Water.
London Iron Trade Exchange.
Medical Press and Circular.
Metropolitan.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Mouvement Industriel Belge.
Musical Standard.
Nature.
Photographic News.
Photographic Times and American Photographer.
Pottery and Glassware Reporter (Pittsburgh).
Produce Markets' Review.
Queen.
Revue Industrielle.
Sanitary Engineering.
Sanitary News (Chicago).
School Board Chronicle.
Schoolmaster.
Science (New York).
Scientific American.
Statist.
Telegraphic Journal and Electrical Review.
United States Patent Office, Official Gazette.
Warehousemen and Drapers' Trade Journal.

Fortnightly.

American Gas Light Journal.
Anthony's Photographic Bulletin.
Brewers' Guardian.
Corps Gras Industriels.
Finance Chronicle.
Gaceta Industrial.
Indian Engineer.
Irish Builder.
Jeweller and Metalworker.
Monde de la Science et de l'Industrie.
Moniteur des Produits Chimiques.
Planters' Gazette.
Publishers' Circular.
Revue Internationale de l'Electricité.

Monthly.

Analyst.
Antiquary.
Art Journal.
Bookbinder.
Bookseller.
Brewers' Journal.
British Mercantile Gazette.
British Trade Journal.
Building Societies and Land Companies' Gazette.
Building World.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette.
Chemist and Druggist.
Dental Record.

Drinks.
Dyer and Calico Printer.
Educational Times.
Electrical Engineer.
Familiar Trees.
Food.
Furniture Gazette.
Gas Engineer.
Health Journal.
Inland Architect (Chicago).
Leather Trades' Circular.
Machinery Market.
Magazine of Art.
Manufacturers' Review and Industrial Record.
Marine Engineer.
Martineau & Smith's Hardware Trade Journal.
Meteorologische Zeitschrift
Midland Naturalist.
Mineral Water Trade Review and Guardian.
Moniteur Scientifique.
Nautical Magazine.
Oesterreichische Monatsschrift für den Orient.
Paper Makers' Circular.
Paper Makers' Monthly Journal.
Photographer's World.
Plumber and Decorator.
Pottery Gazette.
Revue Coloniale Internationale.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sanitary Record.
Science and Art.
Scientific News.
Sugar Cane.
Symons's Meteorological Magazine.
Textile Recorder.
Textile World.
Union Horlogère.
Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

Quarterly.

Asclepiad, by Dr. B. W. Richardson, F.R.S.

NEWSPAPERS.

Belgian News.
Bombay Gazette, Overland Summary.
Ceylon Observer and Weekly Summary of Intelligence.
Ceylon Times, Weekly Summary.
Eastern Post.
Home and Colonial Mail.
London Commercial Record.
London and China Telegraph.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Sheffield and Rotherham Independent.
Times of India (Overland Weekly Edition).
West London Observer.

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PRINTED BY W. TROUNCE, 10, GOUGH-SQUARE, FLEET-STREET, E.C.